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**MILITARY INTELLIGENCE DIVISION W. D. G. S.**

**MILITARY ATTACHE REPORT** G. B.  
(Country reported on)

Subject CHALLENGER I TANK I. G. No. 0501.0501  
(Brief descriptive title)

From M. A. London Report No. R3665-45 Date 29 June 1945

Source and degree of reliability:

Armored Fighting Vehicle School Publication  
AFVP/GI/34. 1-1

SUMMARY.-- Here enter careful summary of report, containing substance succinctly stated; include important facts, names, places, dates, etc.

The Challenger (A30) is a 35 ton tank of the Cromwell type mounting the 17 pounder gun. Armor plate thicknesses are 4" at the gun mantlet and 2 1/2" at turret and hull fronts.

The attached Armament Training Pamphlet on the Challenger I is one of the series of such publications being issued by the Armored Fighting Vehicle School as explained in L. A. London R3381-45. It includes data on the operation and maintenance of the 17 pounder gun, the caliber .30 Browning machine gun, 2" bomb thrower, rear smoke emitters, sighting and fire control equipment and the power traverse system. Detailed gunnery instructions are given, as are photographs and descriptions of the various types of 17 pounder ammunition, including break-down views of the AP Discarding Sabot shot.

Data on the Challenger tank were included in L. A. London R401-45 and other reports previously forwarded by this office, and it is noted that a photograph and some details on the vehicle were given on Page 7 of the May 1945 issue of the Recognition Journal.

This will be of special interest to O.C.O. - Detroit, Armored Board, Armored School, Ordnance School, Armored Vehicle Branch of AGF, Ordnance Research and Development Service, and Ordnance Field Service.

**U. S. WAR DEPT.**

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0625 W. J. DURRENBERGER,  
Major, Ord. Dept.

**JUL 18 1945**

OMA, American Embassy, London, England, 29 June 1945, Forwarded

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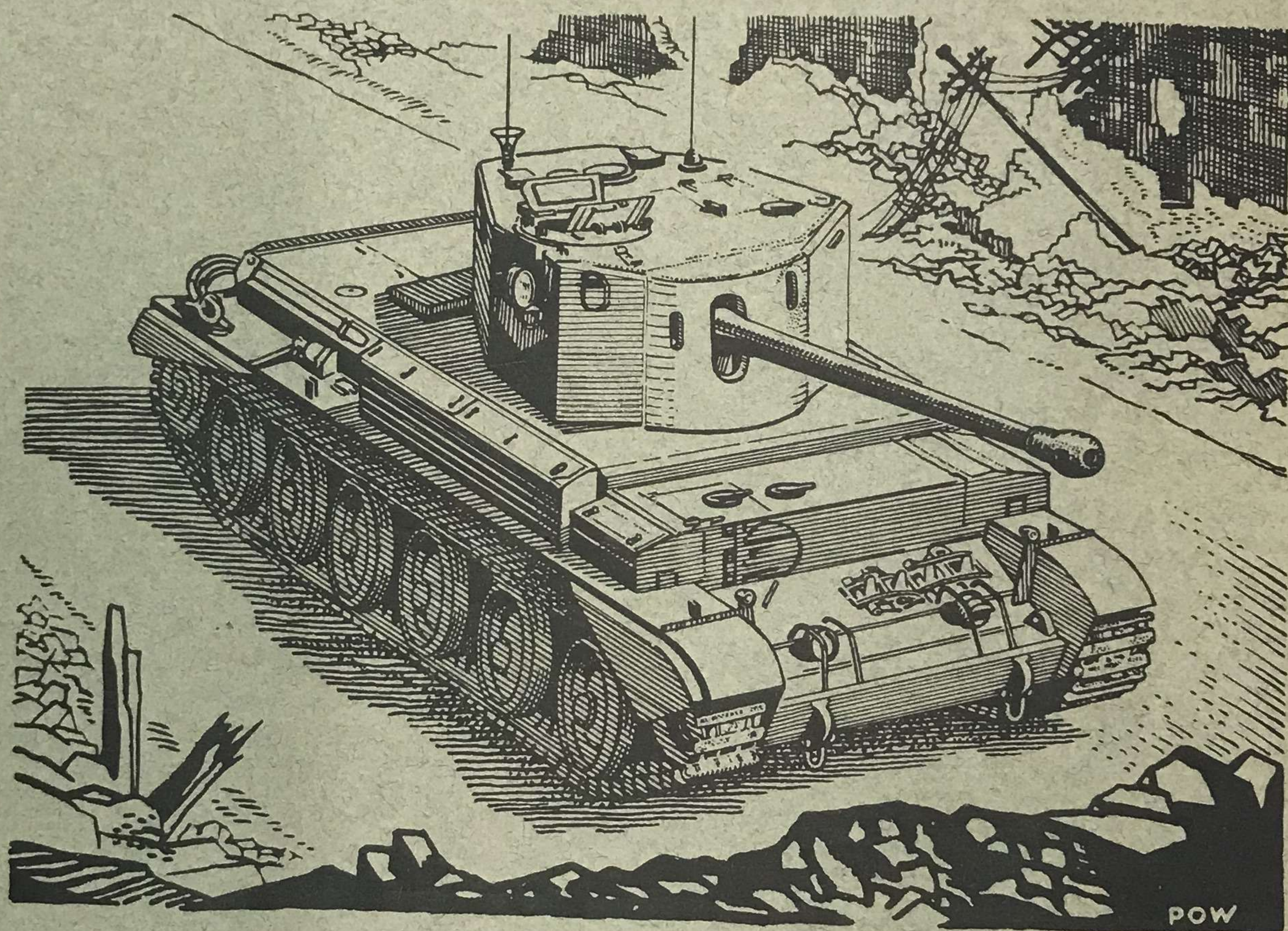
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# CHALLENGER 1



## ARMAMENT TRAINING PAMPHLET

U. O. WAR DEPT.

JUL 18 1945



PRODUCED, PUBLISHED AND ISSUED BY  
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Page 1 of Incl 1 to Report No. R3665.45  
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MAY 1945



The following table is included to assist users of the pamphlet in keeping a note of relevant modifications and Technical Instructions issued subsequently:-

[illegible]



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2. "Action"  
3. "Fire"  
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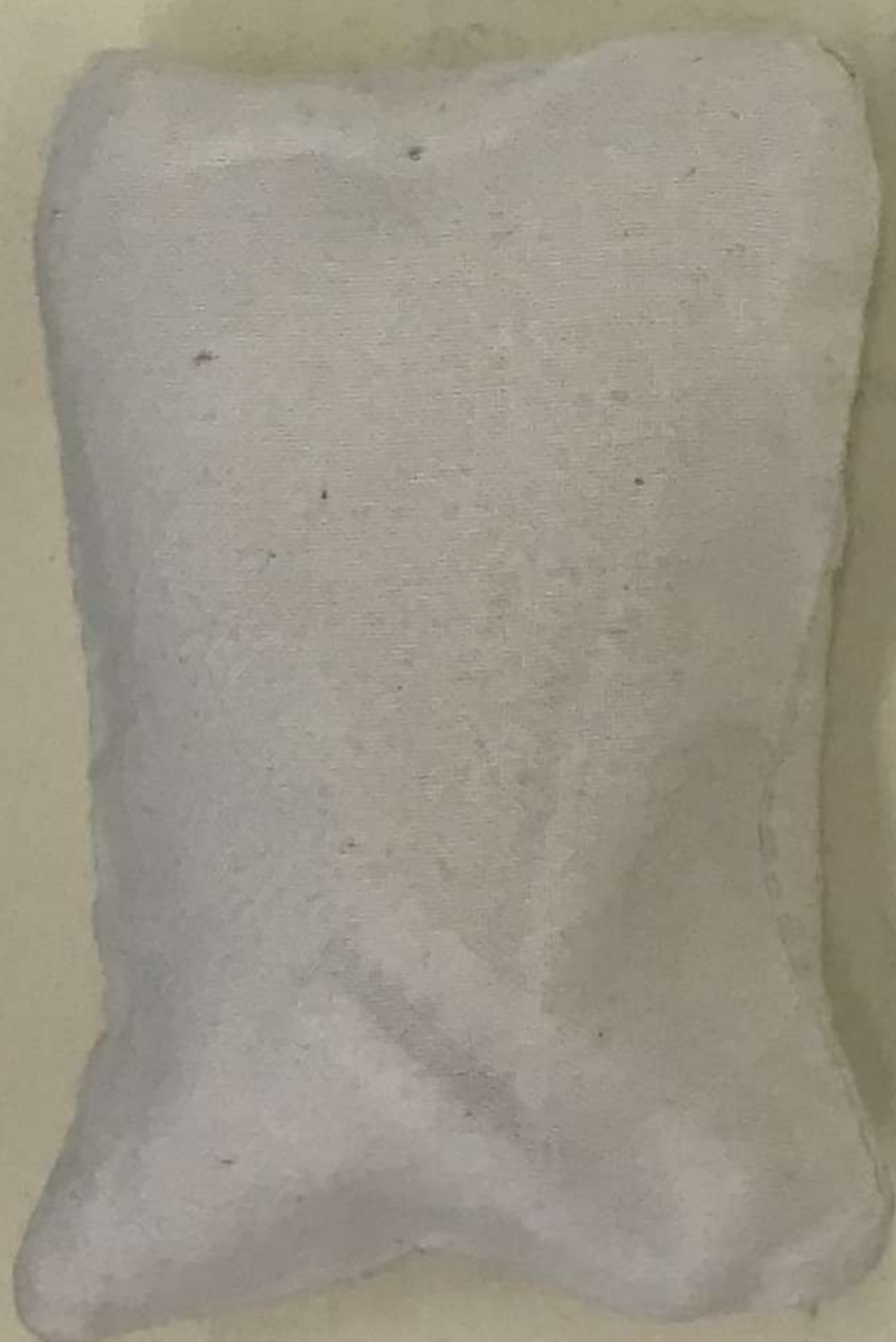
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Weapons.

Introduction.

Rolling.

Stripping and assembly.

Tests and adjustments.

Maintenance.

Mechanism.



1.

CHALLENGER I ARMAMENT.

PREFACE

1. OBJECT AND SCOPE OF PAMPHLET.

A.F.V. School Armament pamphlets are designed:-

- (a) As instructional handbooks.
- (b) As works of reference.

Their primary purpose is to contain information necessary for the crew commander or gunnery instructor to train the crew in tank gunnery. They also contain information which is NOT essential for the crew but which is useful for reference. To distinguish essential data from the non-essential, the non-essential data will appear in italics in the printed pamphlet or be side-lined in the provisional typed copies.

2. LAY-OUT.

The pamphlets are set out in a manner and sequence appropriate for instruction. The sequence of instruction on a weapon which the gunner strips and gets to know intimately differs from that on other equipment which the gunner does NOT strip. The subject-matter is laid out as follows for the two types of equipment :-

<u>Weapons.</u>	<u>Other equipment.</u>
Introduction.	Description.
Handling.	Use.
Stripping and assembling.	Tests and adjustments.
Tests and adjustments.	Maintenance.
Maintenance.	Defects.
Mechanism.	

3. GLOSSARY.

A glossary of terms is included at the end of the pamphlet to ensure that the text is NOT overburdened with an explanation of terms common to the whole of tank gunnery.

4. BIBLIOGRAPHY.

The Challenger armament pamphlet should be read with the following publications:-

Firing tables for 17-pr guns, Mk. 2, 4 & 7 .. . . .	AFVP/MSG/62.
Firing data for 17-pr gun, Mk. 2 .. . . .	AFVP/MSG/66.
Commander's crib .. . . .	AFVP/GI/7.
Range practices .. . . .	MTP No. 34.
	Part 5.
Fire tactics.. . . .	MTP No. 34,
	Part 4.
The machine carbine .. . . .	SAT Vol. I,
	Pamphlet No.21, 1944.
Grenades .. . . .	SAT Vol. I,
	Pamphlet No. 13.
How to use your eyes in the dark .. . . .	AFVP/MSG/17.
Bren LMG .. . . .	SAT Vol. I,
	Pamphlet No. 4.
Range-finder No. 12 .. . . .	SAT Vol. I,
	Pamphlet No. 10.

Pamphlets bearing the serial number AFVP/ / are produced by A.F.V. Publications Section, Bovington Camp, Dorset, and copies may be obtained on application. The other pamphlets are G.S. publications.



# PART I - THE EQUIPMENT AND ITS USES.

## SECTION 1 - INTRODUCTION TO THE ARMAMENT.

### 1. THE WEAPONS.

- (a) 17 PR MK. 2 GUN mounted in the turret.
- (b) .30" BROWNING MACHINE GUN mounted coaxially in the turret.
- (c) 2" BOMB THROWER.
- (d) REAR SMOKE EMITTERS (2)
- (e) .45" THOMPSON OR 9 mm STEN MACHINE CARBINE
- (f) BREN L.M.G.
- (g) GRENADES No. 36, No. 80 or No. 81 and No. 83 Mk. 2.
- (h) PISTOL, SIGNAL.

### 2. THE GUN CONTROLS.

Geared elevation.

Electric powered traverse (Metadyne)

Finger-operated solenoid firing gear (17 pr only) and mechanical pedal (17-pr and coaxial M.G.).

### 3. FIRE CONTROL EQUIPMENT.

- Telescope No. 43 x3 ML Mk. 1 (1st 23 vehicles)
- Telescope No. 43 x3 ML Mk. 3 (subsequent vehicles)
- A.F.V. Sight gear No. 2.
- Marked elevating wheel.
- Blade vane sight No. 1. or twin blade sighting vane No. 2.
- Range-finder No. 12 (Two per squadron).
- Sight clinometer Mk. 4.
- Field clinometer Mk. 6 (one per squadron).
- Prismatic binoculars No. 5.

### 4. AMMUNITION.

Cartridges, Q.F. 17-pr (APCBC, APDS or HE)	48 rounds.
Cartridges, .30 Cal. AP and tracer	3750 rounds (23 boxes)
Bombs, 2" smoke	30
Generators, smoke No. 8 Mk. 5 or 6.	4.
Cartridges, SA .45".	320 (16 magazines)
or	
Cartridges, SA 9 mm.	256 (8 magazines)
Cartridges, SA .303"	600
Grenades, hand	12
Cartridges, signal and illuminating	18

### 5. THE CREW.

Crew commander, gunner, two loaders and driver.

SECTION 2  
Equipment required:- 17-pr gun  
stand.  
Telescope  
Sight clin  
Gun and mo

17-pr Mk. 2 gun  
Distance of 17-pr Mk. 2 gun  
7 sets (approx).

3 inches or 76.2mm  
VELOCITY  
3,950 f  
2,900 f  
2,950 f  
1,800 f

EXTREME EFFECTIVE  
800 yd  
2,500 yd  
12,000 yd

PERATION  
The gun is quick-firing  
fixed ammunition an  
under the control  
coil, running-out spri  
During the run-out of th  
breach remains open unti

The SA gear will

CREW  
Crew commander, gunner,  
AMMUNITION  
The following is a guid  
20, APDS,

Equipment required:- 17-pr  
mount  
Drill  
Cockin

Open the breech  
and rotating the  
20. Return the  
the retaining



3.

SECTION 2 - THE 17-PR MK.2 GUN

1. INTRODUCTION

Equipment required: - 17-pr gun mounted in an AFV or on an instructional stand.

Telescope No.43 x3 ML Mk.3 (or 1)

Sight clinometer Mk. 4.

Gun and mounting tools and spares.

(a) NAME

Ordnance QF 17-pr Mk.2 gun.

(b) WEIGHT

17 cwt (approx).

(c) CALIBRE

3 inches or 76.2mm

(d) MUZZLE VELOCITY

APDS - 3,950 ft/sec (approx)

APCBC, APC

and AP - 2,900 ft/sec.

HE - 2,950 ft/sec (full charge).

1,800 ft/sec (reduced charge)

(e) RANGE (extreme effective)

APDS - 800 yards.

AP - 2,500 yards.

HE - 12,000 yards.

(f) OPERATION

The gun is quick-firing and semi-automatic. It is loaded with Q.F. fixed ammunition and when fired recoils approximately 12 inches under the control of a hydraulic buffer system. After recoil, running-out springs return the gun to the firing position. During the run-out of the gun the empty case is ejected and the breech remains open until another round is loaded.

Note: The SA gear will not operate when firing HE reduced charge.

(g) GUN CREW

Crew commander, gunner, two loaders.

(h) AMMUNITION

The following is a guide to the proportion of ammunition carried:-

20% APDS, 30% APCBC, 45% HE and (when available) 5% smoke.

2. HANDLING.

Equipment required: - 17-pr Mk.2 gun in an AFV or on instructional mounting.

Drill rounds.

Cocking lanyard No. 4.

(a) TO LOAD (offside)

- (i) Open the breech by pressing the BML retaining catch inwards and rotating the BML to the rear and down as far as it will go. Return the BML to the vertical position and ensure that the retaining catch engages with the breech ring.



4.

- (ii) Take a round from the ammunition bin, remove the cartridge clip, grasp the neck firmly with the right hand and support the base with the left.
- (iii) Lift the round over the side of the deflector, place the projectile in the chamber and rest the cartridge case on the loading platform.
- (iv) With the right hand, slide the round smoothly forward into the breech.
- (v) When the breech has closed, ensure that the loading platform is vertical, set the safety switch (if fitted) to "ON" and shout "Loaded". Check that the pilot light shows RED.
- (vi) Take another round from the bin, remove the cartridge clip, hold the round with the projectile pointing to the right and extend the arms fully downwards against the legs in readiness to re-load.

(b) TO FIRE.

ELECTRICALLY

- (i) Ensure that the master switch is ON.
- (ii) Press the switch on the handle of the elevating wheel with the index finger.
- (iii) Release pressure from the switch IMMEDIATELY after firing.

MECHANICALLY.

- (i) Push the selector lever UP for 17-pr.
- (ii) Press the pedal sharply.
- (iii) Release pressure IMMEDIATELY after firing.

(c) TO RE-COCK

- (i) Fit the loop of the cocking lanyard over the cocking handle.
- (ii) Pull to the rear and remove the lanyard.

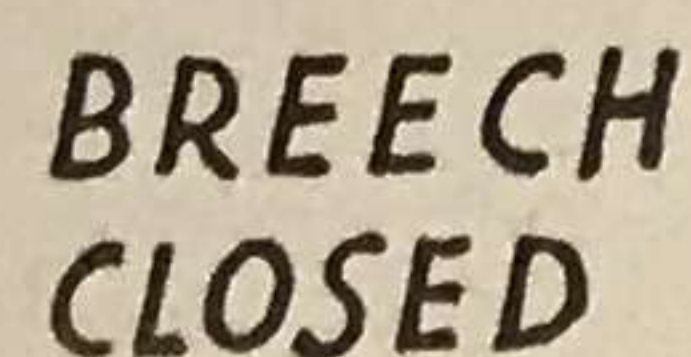
(d) TO SET THE GUN AT "SAFE"

- (i) Cock the gun.
- (ii) Turn the safety catch on the striker case to "SAFE".

(e) TO UNLOAD

- (i) Open the breech slowly and return the BML to the vertical position.
- (ii) Remove the round from the breech and replace it in the bin.
- (iii) Examine the bore and chamber to ensure that the gun is clear.
- (iv) If the gun is clear, close the breech by rotating the BML to the rear to take the pressure of the breech closing spring. With the BML held down, rotate the extractors forward and allow the closing spring to drive the breech block up under control of the BML.
- (v) Ease the mainspring by holding the cocking handle, pressing the trigger and controlling the forward movement of the striker spindle.





17 PR. MK 2  
BREECH MECHANISM



5.

### 3. STRIPPING AND ASSEMBLING.

#### Object.

To clean, lubricate and inspect the gun and to replace defective parts.

#### Rules of stripping.

First prove the gun to be unloaded.  
Strip to the correct sequence.  
Never strip against time.  
Use the correct tools correctly.  
Lay the parts in a clean, dry place.

#### (a) THE BREECH MECHANISM.. (See Figure 1).

Equipment required:- Gun mounted in an AFV or on an instructional mounting.  
30" length of stout timber.  
Small screwdriver.  
11" adjustable spanner.  
1/4" x 3/16" spanner.  
5/16" spanner.  
Pliers.  
No.18 drift.

Men required:- Two.

Note:- The breech must be closed and the gun at SA.

#### TO STRIP.

##### (i) The deflector.

With the large adjustable spanner, unscrew the screwed axis pins of the deflector. **Remove the deflector.**

##### (ii) The gunner's shield.

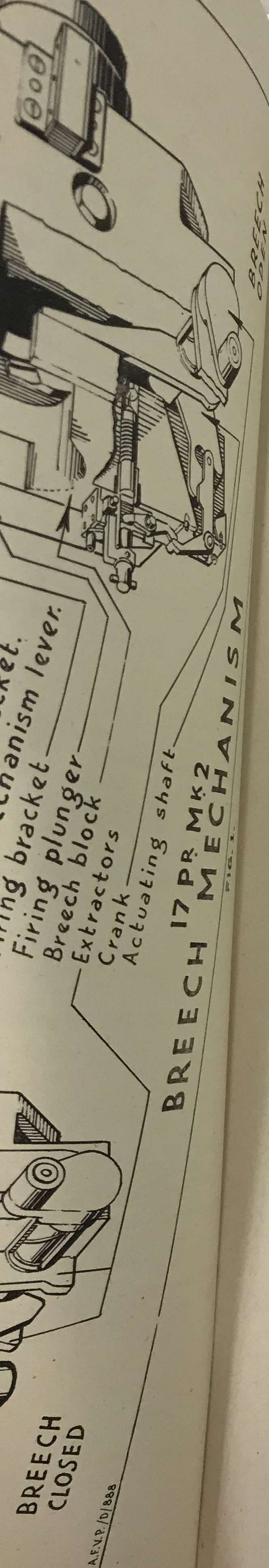
With the 5/16" spanner, remove the five bolts securing the shield to the cradle. **Lift off the shield.**

##### (iii) The rack pinion cover.

With the 3/16" spanner, remove the cover securing bolts. **Lift off the cover.**

##### (iv) The striker case.

Cock the gun by opening the breech slightly with the BML.  
Set the safety catch to **SAFE**. Disengage the retaining plunger by pulling the finger piece to the rear. Rotate the striker case clockwise as far as possible and withdraw it from the breech block. Set the safety catch to **FIRE**, and hold the case firmly in the left hand. Ease the mainspring by pressing the sear and controlling the cocking handle with the other hand.





6.

(v) The rack pinion.

Place a length of stout timber between the turret floor and the breech block and elevate the gun until the timber is supporting the block. Remove the split pin, nut and washer from the left of the actuating shaft. Hold the intermediate cocking lever to the rear and push the actuating shaft to the right until the rack pinion can be removed.

(vi) The actuating shaft and B.M.L.

With the timber safely supporting the breech block, depress the gun slowly until the striker case retaining plunger recess in the breech block is in line with the screwed plugs in the breech ring. Support the extractors and crank and withdraw the actuating shaft. Rotate the BML to the rear and remove it.

(vii) The crank and extractors.

Support the crank and trip the intermediate cocking lever to the rear. Rotate the crank forward and lift it out. Remove the extractors by lifting and rotating forward.

(viii) The breech block.

Take the weight of the block, remove the timber and remove the block from the breech ring. To prevent burrs the breech block will not be removed from the tank unless necessary.

(ix) The actuating shaft bush.

Remove the bush from the left hand side of the breech ring.

TO ASSEMBLE

(i) The actuating shaft bush.

Replace the bush in the breech ring.

(ii) The breech block.

Insert the breech block into the breech ring and support it with the timber so that the retaining plunger recess in the block is in line with the screwed plugs in the breech ring. Elevate or depress the gun if necessary.

(iii) The crank and extractors.

Place the crank in position with the roller to the left, engage the roller with the intermediate cocking lever and lift the splined portion of the crank into the breech ring. Insert the extractors into the underside of the breech ring and engage the stops of the extractors with the recesses in the breech block.







7.

(iv) The BML and actuating shaft.

Replace the BML and engage the catch in its recess. Support the crank and extractors and elevate the gun until the crank and extractors are so aligned that the actuating shaft can be replaced. Insert the actuating shaft into the breech ring and push it through the extractors and crank until the threaded end of the shaft is flush with the left side of the breech ring. Elevate the gun to close the breech, ensuring that the timber support does not slip. Push the extractors forward as the breech block rises in the breech ring. Continue to elevate the gun slowly until the breech block is in its highest position. Pull back the intermediate cocking lever to lock the breech.

(v) The rack pinion.

Hold the intermediate cocking lever to the rear and replace the rack pinion with the teeth engaging with the rack. Push the actuating shaft fully to the left. Replace the washer, nut and split pin.

(vi) The striker case.

Cock the mechanism of the case and put the safety catch to SAFE. Insert the striker case into its recess in the breech block and push the striker case forward. Rotate it to the left to engage the interrupted flanges and the retaining plunger. Set the safety catch to FIRE and ease the spring.

(vii) The rack pinion cover.

Replace the cover.

(viii) The gunner's shield.

Replace and secure the shield.

(ix) The deflector.

Replace, ensuring that the axis pins are screwed in securely.

(b) THE STRIKER CASE. (See Figure 2.)

TO STRIP.

(i) The cocking lever.

Remove the striker case from the breech block and, with the mechanism cocked, remove one split pin from the cocking lever axis pin. Remove the axis pin and the cocking lever. Put the safety catch to fire and ease the main spring.

(ii) The cocking handle.

Remove the split pin securing the cocking handle and unscrew the handle to the left, ensuring that the striker spindle moves forward and is supported.

(iii) The striker spindle and mainspring.

Remove the spindle and mainspring.

Spring seat.  
Rollers.  
Case.  
Axis pin.  
Cocking lever.  
**17 PR MK 2  
STRIKER CASE.**



- Apply slight pressure to the sear and withdraw the cocking sleeve.

- Remove the split pin securing the safety catch retaining pin and remove the pin. Remove the safety catch, at the same time controlling the sear and sear spring.

- Incline the striker case to the left and withdraw the sear and spring.

Insert the spring into its seating in the sear and replace the sear in the striker case.

- Press the sear inwards and replace the safety catch.  
Replace the retaining pin and split pin.

- Fit the mainspring over the striker spindle and insert them into the breech block with the recess cut in the threaded end of the spindle at the 3 o'clock position.

- Fit the striker case into the breech block. Set the safety catch to FIRE, press the sear inwards and replace the cocking sleeve. Ensure that the lug in the cocking sleeve engages correctly with the recess in the spindle.

- Screw the cocking handle on to the striker spindle and replace the split pin.

- With the lower arm of the cocking lever between the intermediate cocking lever and the breech block, insert the upper arm of the cocking lever into the slot in the striker spindle. Replace the axis pin and split pin. Ease the mainspring.

- Remove the striker case from the breech block and ease the main spring. Pull out the staple retaining the firing pin and remove the firing pin. If the firing pin cannot be withdrawn, remove the spindle from the case, insert the No. 18 drift into the small hole in the spindle and lever out the firing pin.



9.

(ii) To replace.

A new firing pin must be gauged before use. Fit the firing pin into the front of the spindle, replace the staple, ensuring that the legs are not too long, cock the mechanism and replace the case in the breech block.

(d) REMOVING AND REPLACING THE MUZZLE BRAKE.

Disengage the washer from the locking ring and muzzle brake. Loosen the locking ring and withdraw the anti-rotation key from the slot in the brake. Unscrew the brake (left hand thread) being careful not to drag the last two or three threads. Replace in the reverse order.

4. TESTS AND ADJUSTMENTS.

(a) GAUGING THE PROTRUSION OF THE STRIKER.

Equipment required :- Gauge protrusion striker No. 38 Mk. 1 or No. 16 Mk. 1.  
Pliers.  
Screwdriver.

(i) Using No. 38 gauge.

With the breech closed, and the striker fired, insert the gauge from the top, so that the gauging edge of the plate is in contact with the front face of the breech block. The minimum should foul the firing pin, while the maximum should clear it. If either of the tests fails, the firing pin must be exchanged.

(ii) Using No. 16 gauge.

Remove the breech block from the gun and replace the striker case in the block. Ease the main spring. Set the No. 16 gauge on the front face of the breech block and at right angles to it. Slide the gauge over the firing pin. The minimum should foul, and the maximum clear the firing pin.

If the firing pin is too long, it can be rubbed down on an oilstone by a gunfitter. If it is too short, it will be exchanged. Insert the spare striker case into the breech block and test the protrusion of the firing pin.

THE BREECH CLOSING SPRING.

Equipment required :- Drill round.

(i) Preparation.

Faulty closing of the breech may be due to burrs, dirt or lack of oil on the breech block or on the guides of the breech recess. It is, therefore, essential to examine the breech block and breech recess before testing the action of the breech closing spring.



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- (ii) To test.

Load the gun with a drill round. If the breech closes sluggishly or fails to close completely, report to a gunfitter.

## TESTING THE SEAR.

Equipment required:- Drill round

- (i) Open the breech and, with a pencil, mark the upper surface of the scar at the point where it protrudes from the striker case body.

- (ii) Load the gun with the drill round.

- (iii) Examine the sear. If the sear has moved to the right, the sear or cocking sleeve is worn. The striker case will be removed from the gun and handed to a gunfitter. Place the spare striker case in the gun and repeat the test.

## 5. MAINTENANCE.

- (2) CLEANING AND LUBRICATION.

## LUBRICANTS AND THEIR USES.

- (i) Engine oil.

Engine oil (e.g. Oil 30 H.D) is used for cleaning and lubricating the 17 pr bore, breech mechanism and outer surfaces.

- (ii) Oil, mineral hydraulic buffer CS 1117B.

This oil is used as a lubricant in very cold weather.

- (iii) Grease.

Grease No. 1 or No. 2 is used for lubricating heavy or slowly moving parts. Grease No. 0 is used in low temperatures (below 32° F.)

- (iv) Graphited grease.

This grease, preserve the inreads of the muzzle brake. is used to

## CLEANING.

Equipment required:-

- Supply of lubricants.
- Brush, plasaba, 3-in No.4 Mk.1 w/staff.
- Tools for stripping.
- Supply of clean rags.
- Boiling water.
- Empty 17-pr case.

[illegible]



(i) Daily cleaning.

If the gun is clean the bore need only be dry cleaned and re-oiled and the breech mechanism, chamber and mounting wiped with an oily rag. To dry clean the bore, remove the muzzle and breech covers. Insert the cleaning brush into the muzzle and push it through to the breech ring. Place one thickness of cloth round the brush and draw the brush through the bore. With a clean piece of cloth wipe all oil from the walls of the chamber and the baffles of the muzzle brake. Inspect the chamber, bore and muzzle brake baffles to ensure that all oil, moisture or dirt has been removed. To re-oil the bore, saturate a clean piece of cloth with engine oil, insert it into the muzzle and push it slowly through the bore with the brush stave. Wipe the walls of the chamber with a well-oiled piece of cloth. Ensure that a complete film of oil covers the bore and chamber. Close the breech and ease the firing mechanism. Wipe the muzzle brake baffles and exterior with an oily cloth. Replace the breech and muzzle covers and leave the gun in the travelling position.

If the gun has become wet or dusty, it must be stripped completely and all parts dry cleaned and re-oiled before assembling. The bore must be dry-cleaned and re-oiled and the mounting wiped over with an oily rag.

(ii) Cleaning before action.

Whenever possible, the gun will be stripped, cleaned and inspected and all frictional surfaces lightly lubricated with engine oil. The bore, chamber and outer surfaces of the gun will be left dry cleaned.

(iii) Cleaning during a lull in action.

Clean out the chamber with a piece of dry rag, clear any brass chippings or dirt from the breech mechanism and lightly oil the frictional parts. Remove the striker case and clear any dirt or luting from the striker recess in the breech block. Clean and inspect the firing pin and return the striker case to the breech block.

Locate and remedy any faults that have been observed during firing.

(iv) Cleaning after action.

Immediately after action and while the gun is still warm, superficial fouling will be removed from the bore and chamber by dry cleaning, after which the bore and chamber will be oiled to prevent corrosion.

On return to harbour or camp, dry clean the bore and chamber and scour the bore to remove internal fouling; during training, and whenever possible after battle, this will be done with boiling water. To scour the bore, remove the muzzle brake, place an empty case in the chamber and close the breech. Elevate the gun and fill the barrel with boiling water to heat the metal. When the barrel is hot, drain off the water



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and partially <sup>fill</sup> again with boiling water. Insert the cleaning brush into the muzzle and scrub the bore throughout its length, using fresh water from time to time. Care must be taken not to force the cleaning brush into the empty case, as the brush may become jammed. Finally drain off the water and remove the empty case. If water is unobtainable, scour the bore with an oily brush. Dry clean the bore and chamber and inspect for damage and metallic fouling. If metallic fouling is thought to be excessive or damage is present, report to a gunfitter. Dry clean and examine the muzzle brake. If cracks, burrs or spikes are present, report to a gunfitter. Clean all traces of carbon from the threads of the muzzle and muzzle brake. Grease the threads with graphited grease. Re-oil and re-assemble. Strip, dry clean and examine the breech mechanism with particular attention to the striker unit recess in the breech block and the firing hole bush. Report any defect to a gunfitter. Oil and assemble the mechanism. When the barrel has cooled, oil the bore and chamber. Replace the muzzle and breech covers. During daily cleaning of the bore for the next ten days, the cloth with which the bore has been cleaned will be closely examined for signs of sweating in the barrel, which will be revealed by the presence of carbon on the cloth. If sweating has occurred, the bore should be scoured with boiling water or <sup>with</sup> oil, dry cleaned and re-oiled.

## SPECIAL CONDITIONS.

(i) Sand or dust.

The working parts of the gun must be cleaned frequently. Lubrication must be reduced to a minimum. Wipe the parts of the gun with a lightly oiled cloth to prevent the formation of rust and lubricate the gun during firing. Keep the external and non-frictional parts of the gun absolutely dry. The bore should be protected by the use of a flimsy muzzle cover which can be blown off when the gun fires. Keep the breech cover on until action is imminent.

(ii) Cold weather.

Oil, mineral hydraulic buffer (CS 1117B) will be used for lubrication in cold climates. If this oil is not available, it is better to dispense with all lubricants rather than use those which will congeal.

## SPARES AND TOOLS

All spare parts should, at the first opportunity, be assembled in the weapon for which they are issued, to make sure that they fit and are serviceable. Spare part containers will be clean and maintained in a serviceable condition. When the spares have been tested, they will be lubricated to prevent rust and stowed in the correct place in the tank. Spares will be dry cleaned and inspected during the weekly cleaning of armament, and before and after action. Tools will be kept clean and serviceable. If a tool becomes worn or damaged, it should be exchanged. Before stowing tools and accessories, those made of steel should be lightly oiled to prevent their rusting.



6. MECHANISM.

Equipment required: 17-pr Mk. 2 gun mounted in an AFV or on an instructional mounting.  
Drill round.  
Tools for stripping.

(a) ACTION ON LOADING.

PREPARATION.

Open the breech.

DEMONSTRATION.

Load the gun with a drill round and control the closing of the breech with the BML.

EXPLANATION.

(i) Insertion of the round.

As the round moves forward into the chamber, the rim of the cartridge case strikes the nibs of the extractors and, rotating the extractors, withdraws the stops of the extractors from the recesses in the breech block. The breech block is now free to rise.

(ii) The upward movement of the breech block.

The breech closing spring now re-asserts itself, forces the rack upwards and causes the rack pinion, actuating shaft and crank to rotate. As the crank rotates, the crank roller bearing on the inclined plane in the breech block forces the block to rise.

(iii) The forcing of the round into the chamber.

As the breech block rises, the bevel on its front face strikes the base of the round and forces it into the chamber. The inclined guides and grooves of the breech block cause the block to move forward as it rises, thus forcing the round fully into the chamber. The upward movement of the breech block is limited by the crank which contacts the stop surface in the breech ring.

(iv) The locking of the breech.

The breech is locked after the final movement of the crank by the direction of thrust through the crank roller which has passed the top dead centre of its travel.

(b) ACTION ON FIRING.

PREPARATION.

Load the gun with a drill round.

DEMONSTRATION.

Fire the gun.



EXPLANATION

(i) The firing gear.

The gun is fired electrically by pressing the firing switch which energises the solenoid. The action of the solenoid transmits pressure through a series of rods and levers to the firing lever on the gun. The firing lever forces the firing plunger and sear to the right, compresses the sear spring and releases the cocking sleeve. The cocking sleeve and striker spindle move forward under pressure of the main spring and cause the firing pin to strike the cap and fire the round. The gun is fired mechanically by pressing the pedal on the floor of the turret. This pressure is transmitted through the rods and levers to the firing lever on the gun. The subsequent action is similar to that described above when the gun is fired electrically.

(ii) The loader's safety switch.

When the striker has been released, the trip lever of the firing gear forces the trip upwards and breaks the electrical circuit. The magnetic field in the solenoid breaks down and the rods and levers return to their normal position. This action ensures that the gun cannot be fired accidentally, although the firing switch may be pressed when the gun is loaded, until the trip switch has been re-set.

(iii) Sealing of the breech.

The rapid burning of the propellant charge causes the cartridge case to expand in all directions against the chamber. This expansion prevents the escape of gases to the rear around the outside of the case.

(iv) Recoil.

The explosion causes the gun to recoil. During recoil the firing lever on the gun is disengaged from the firing lever on the mounting and returned to normal by the action of its spring.

(v) The action of the muzzle brake.

As the projectile leaves the muzzle, the expanding gases from the propellant charge enter the muzzle brake and, striking the baffles, exert a forward pull on the barrel to reduce the force of recoil.

(c) ACTION ON UNLOADING.

PREPARATION.

Load the gun with a drill round and ease the firing mechanism.

DEMONSTRATION.

Open the breech slowly with the BML.



EXPLANATION.

(i) The rotation of the actuating shaft.

As the gun runs out, the roller on the lever of the actuating shaft strikes the SA cam on the mounting and causes the shaft to rotate.

(ii) The withdrawal of the firing pin.

The crank rotates with the actuating shaft and pivots the intermediate cocking lever about its axis in the breech block. The rear arm of the intermediate cocking lever moves forward and, bearing against the lower arm of the cocking lever, causes the upper arm to move to the rear. The upper arm of the cocking lever, engaged in a slot in the striker spindle, draws the spindle to the rear and withdraws the firing pin from the base of the round. This movement of the crank unlocks the breech.

(iii) The opening of the breech.

The breech does not open until the firing pin has been withdrawn. The continued rotation of the crank causes the crank roller to bear against the lower surface of the crank recess in the breech block and force the block down.

(iv) The ejection of the empty case.

When the breech block has moved down far enough to open the breech, the shoulders of the block strike the actuating arms of the extractors and cause the extractors to rotate to the rear. This movement of the extractors ejects the empty case as the nibs of the extractors are engaged in front of the rim of the case.

(v) The open position of the breech.

The downward movement of the breech block is limited by the stop on the crank making contact with the breech ring. The breech block is then forced upwards by the breech closing spring, and is retained in the breech open position by the engagement of the stops on the extractors with the recesses in the breech block.

(vi) The compression of the breech closing spring.

As the actuating shaft rotates, the rack pinion forces the rack downwards, which compresses the breech closing spring.

(vii) The SA cam.

The roller on the actuating shaft is now clear of the SA cam.

(d) THE COCKING ACTION.

PREPARATION

Close the breech and ease the mechanism.



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## DEMONSTRATION.

Slowly open the breech.

## EXPLANATION.

- (i) The cocking lever, striker spindle and cocking sleeve.

As the crank rotates, the intermediate cocking lever pivots forward against the lower arm of the cocking lever causing the upper arm to move to the rear. The upper arm of the cocking lever draws the striker spindle and cocking sleeve to the rear. The mainspring is thus compressed between the front end of the spindle and the striker case.

- (ii) The cocked position.

As the arm of the cocking sleeve moves to the rear, its inclined surface bears against the inclined surface of the sear, forces the sear to the left, and places the bent of the sear in front of the arm of the cocking sleeve. The sear spring ensures positive engagement of the sear and cocking sleeve.

## (c) SAFETY ARRANGEMENTS.

## PREPARATION.

Load the gun and, with the BML, move the breech block down about one quarter of an inch.

## DEMONSTRATION.

Attempt to fire the gun.

## EXPLANATION.

The gun cannot be fired until the breech is locked for any of the following reasons :-

- (i) The firing lever on the gun cannot actuate the sear if the recess in the breech block is not opposite the firing plunger.
- (ii) The firing pin may not be in line with the cap of the round.
- (iii) If the firing pin were released, the cocking lever would foul the intermediate cocking lever and prevent the firing pin reaching the cap.

One .30" instruction  
Belt, bel  
Wrench, sp  
Roll, sp  
Case (sp)  
Clearing

In no circumstances  
ammunition be used  
each lesson, the in  
rounds carefully to  
rounds amongst them

Machine gun cal  
13.3 - heavy barrel)  
pistol grip.

WEIGHT.

9 lbs.

WEIGHT

13 lbs.

WEIGHT VELOCITY

2	(M2)	2
10	(M2)	2
100	(M1)	2

WEIGHT

10 to 1200 yards (normal)  
10 to 2000 yards (extended)

RATE OF FIRE

25-40 rounds per minute

WEIGHT AND LAYING.

The telescope is used  
the gun is levelled  
specified number of

WEIGHT.

The machine gun is  
used, the round  
the working  
of the next  
operationally until

WEIGHT.

The machine gun is

WEIGHT.



SECTION 3 - THE .30" BROWNING MACHINE GUN

1. INTRODUCTION.

Equipment required: - One .30" Browning machine gun mounted on an instructional stand, or in an AFV.  
Belt, belt box and drill rounds.  
Wrench, combination M6.  
Roll, spare parts M13 (full)  
Case (spare breech block) M2 (full)  
Clearing plug.

Note: In no circumstances, except on the range, will live ammunition be used for instructional purposes. Before each lesson, the instructor will inspect all drill rounds carefully to ensure that there are no live rounds amongst them.

(a) NAME

Browning machine gun calibre .30 H.B. M1919A4 fixed or flexible (H.B = heavy barrel). The flexible machine gun is fitted with a pistol grip.

(b) WEIGHT.

31 lbs.

(c) CALIBRE

.30-ins.

(d) MUZZLE VELOCITY

AP	(M2)	2,775 ft/sec.
Ball	(M2)	2,800 ft/sec.
Tracer	(M1)	2,715 ft/sec.

(e) RANGE

Up to 1200 yards (normal).  
Up to 2000 yards (exceptional).

(f) RATE OF FIRE

425-450 rounds per minute.

(g) SIGHTING AND LAYING.

The telescope is used for direct fire. For semi-indirect fire the gun is levelled by means of a clinometer and elevated a specified number of turns and divisions of the elevating wheel.

(h) OPERATION.

The machine gun is loaded by hand and when the trigger is pressed, the round is fired. The force of the explosion drives the working parts to the rear to eject the empty case and feed the next round. The machine gun fires automatically until the trigger is released.

(i) GUN CREW.

Crew commander, loader and gunner.



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(j) AMMUNITION.

3,750 rounds are carried in fabric belts, each containing 250 rounds and packed in metal boxes (M1 or M2). Belts are filled in the proportion of 4 AP to 1 tracer.

2. HANDLING.

Equipment required: As for Introduction.

(a) TO LOAD.

- (i) Open the cover, place the first round in the belt under the transporter and close the cover.
- (ii) Lower the cocking handle guard, pull back and release the cocking handle and raise the guard.

(b) TO FIRE.

- (i) Set the selector lever to M.G. (lowest position).
- (ii) Press the firing pedal.

(c) TO UNLOAD.

- (i) Remove the belt from the machine gun and close the cover.
- (ii) Lower the cocking handle guard, pull back and release the cocking handle and press the trigger.

3. STRIPPING AND ASSEMBLING.

Object:

To clean, lubricate and inspect the machine gun or to replace a defective part.

Rules of stripping.

First ensure that the machine gun is unloaded.  
Strip to the correct sequence.  
Never strip against time.  
Use the correct tools correctly.  
Lay the parts in a clean, dry place.

(a) NORMAL STRIPPING.

Equipment required:- Machine gun mounted in an AFV or on an instructional mounting.  
Screwdriver.  
Drift.

TO STRIP.

(i) Return spring and rod.

Open the cover fully. Hold the cocking handle to the rear and with a screwdriver turn the slot at the end of the return spring rod to the horizontal position. Push forward the rod and turn clockwise 90 degrees. The studs on the rod will thus be engaged in a groove in the breech block so that the spring is held under compression. Push forward the cocking handle.



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(ii) Rear plate.

Push forward the cover catch and lift off the rear plate by sliding upwards.

(iii) Cocking handle.

Pull back and remove the cocking handle.

(iv) Breech block.

Remove by sliding to the rear. Turn the transporter vertical and withdraw it to the left. Grasp the breech block with the left hand. With the thumb and forefinger of the right hand push in and rotate the return spring rod anti-clockwise until the slot is horizontal. Allow the spring to force out the rod for a few inches. Grasp the spring and rod and withdraw both with a sharp movement. Rotate the cocking lever to the rear. Remove the axis pin and cocking lever. Press down the sear to release the firing pin. Press the sear spring downwards and outwards to the left with a drift. Withdraw the sear. Release the sear spring and push upwards the sear spring pin with a drift. Tilt the breech block and allow the firing pin to slide out.

(v) Lock frame.

Raise the latch (if fitted) and push in the trigger axis pin with a drift, while the lock frame, barrel extension and barrel are withdrawn as a unit. Remove the lock frame when the barrel extension is clear of the gun body, by holding the barrel extension with the left hand and the lock frame in the palm of the right. With the thumb of the right hand, rotate the accelerator in a forward direction, maintaining a firm grip on the lock frame.

(vi) Barrel and barrel extension.

Withdraw the barrel and barrel extension, taking care to support them so as to prevent damage to the barrel bearing in the gun body.

TO ASSEMBLE.

(i) Barrel and barrel extension.

Replace the barrel and barrel extension so that the extension is still clear of the gun.

(ii) Lock frame.

Replace the lock frame on the barrel extension. Hold the barrel extension with the left hand and the lock frame in the right hand with the index finger supporting the accelerator. Place the cams of the accelerator against the forward face of the T-piece on the barrel extension. Insert the cam projections of the lock frame into the guides on the barrel extension and, keeping the hand clear of the trigger push forward



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into the lock frame. Push down the tips of the accelerator to ensure positive locking. Push the parts fully forward. The trigger axis pin must be forced inwards with the drift to clear the right side plate. Ensure that the pin fits correctly in its recess. Press down the latch.

(iii) Breech block.

Re-assemble the parts of the breech block in the reverse order. In assembling the firing pin, ensure that it protrudes through the firing pin hole. Its bent must face downwards. Press down on the finger piece of the trigger (to prevent the accelerator being tripped) and replace the breech block with the cocking lever forward.

(iv) Cocking handle.

Replace the cocking handle with its collar within the side plate.

(v) Rear plate.

Press forward the cover catch and replace the rear plate.

(vi) Return spring and rod.

Hold the cocking handle to the rear and rotate the return spring rod anti-clockwise 90 degrees. Ensure that the transporter is down and allow the breech block to go fully forward. Ensure that the stud of the feed lever is to the left and close the cover. Test the gun by cocking and firing.

(b) ADDITIONAL STRIPPING.

Equipment required:- Wrench for removing the front cone.  
Wrench, combination M6.  
Screwdriver.

(i) Front cone (plug front barrel bearing).

Punch out the front locking band and screw off the front cone and front barrel bearing (right hand thread). Re-assemble in the reverse order. (Where the front cone and barrel bearing can be removed separately, it will be necessary to punch out the rear locking band.)

(ii) Feed mechanism.

Remove the screw securing the feed lever pivot. Push out the pivot and remove the feed lever. Withdraw the feed slide, push out the feed pawl axis pin and remove the feed pawl and spring. Hold the retaining pawl and withdraw the axis pin. Remove the retaining pawl and spring. Re-assemble in the reverse order.

(iii) Cover catch.

Remove by sliding to the rear. In re-assembling, push up the spring and press the catch home.

Push out the  
compress the barrel  
Re-assemble in the

(v) Barrel extension.  
Unscrew the barrel  
the breech lock  
Re-assemble in the  
bevelled edges of  
pin hole is at the  
fully on to the

Note: The barrel  
from the

ADJUSTMENTS

Machine guns are first iss  
by an armourer as foll  
to be fitted and tested  
machine gun periodically.

BRIDGE HEAD SPACE.

Bridge head space is the  
block when fully forw  
adjustment given below  
bridge headspace will ca

To test (gunner)

When the gun is fully  
into the barrel exten  
and note whether the  
transition block and b  
adjustment for head  
adjust as follows:-

To adjust (gunner).

Withdraw the breech  
barrel extension by  
tool, screwdriver or  
adjustment and cont  
the breech block

the timing of the  
released before  
the gun will probab  
the gun will probab  
the gun will probab



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(iv) Lock frame.

Push out the accelerator axis pin, spring and trigger. Compress the barrel return spring to withdraw the rod and spring. Re-assemble in the reverse order.

(v) Barrel extension.

Unscrew the barrel extension from the barrel. Remove the breech lock pin and breech lock. Re-assemble in the reverse order, ensuring that the bevelled edges of the breech block are forward and the pin hole is at the bottom. Screw the barrel extension fully on to the barrel.

Note: The barrel extension will normally be removed from the barrel only for cleaning after firing.

4. TESTS AND ADJUSTMENTS

When machine guns are first issued to units, they will be tested and adjusted by an armourer as follows and tested by firing. Spare parts will also be fitted and tested. Thereafter the gunner will test the machine gun periodically.

(a) CARTRIDGE HEAD SPACE.

Cartridge head space is the distance between the front face of the breech block when fully forward and the rear face of the barrel. The adjustment given below is intended to maintain minimum headspace. Excessive headspace will cause separated cases.

(i) To test (gunner)

When the gun is fully assembled with the barrel screwed fully into the barrel extension, allow the breech block to go forward and note whether the barrel locking notches show between the trunnion block and barrel extension. If they are not visible, adjustment for headspace is correct. If they are visible, adjust as follows:-

(ii) To adjust (gunner).

Withdraw the breech block and slacken the barrel from the barrel extension by one notch by means of the combination tool, screwdriver or nose of a round. Re-test after the adjustment and continue to take off one notch at a time until the breech block goes forward.

(b) TIMING.

If the timing of the machine gun is incorrect, i.e. the firing pin is released before the working parts are fully forward, the transporter will probably fail to grip the round in the belt, because the working parts are driven to the rear before completing the forward movement.



22.

To test (gunner)

Cock the machine gun and ease the working parts forward on to a .074" Cal. .30 timing gauge (or suitable coin, e.g. half a crown) held between the trunnion block and barrel extension. Press the trigger. If the timing is correct, the firing pin will NOT be released. Remove the gauge and check that the firing pin is released when the trigger is pressed. If the timing is incorrect, report to an armourer.

(c) POSITION OF FEED SLIDE.

Wear in the feed mechanism is rapid and if the feed slide is not carried fully to the right, any of the following faults may occur with consequent stoppages:-

1. The belt may become ruckled and clogged in the feedway.
2. The transporter may strike the base of the round and cause the bullet to telescope into the case and form a short round.
3. Unless the belt pocket is supported, the pocket may be dragged to the rear as the round is withdrawn and so cause the belt to slew in the feedway and the round to catch in the feed guides and prevent feed.
4. A heavy belt pull in conjunction with backlash in the feed mechanism may cause feed failure as described under 2 or 3 above.

To test (gunner).

With the machine gun assembled and the cover closed, check the position of the feed slide. Push it fully to the left and note whether it protrudes to the right of the cover by at least  $\frac{1}{32}$ ". If the position of the feed slide is incorrect, report to an armourer.

(d) RECOIL BUFFER.

The purpose of the buffer is to absorb shock and not to act purely as a rebound unit. If the buffer is solid, it will cause vibration and may increase dispersion of shots.

To test (gunner)

Tighten the adjusting screw fully and note whether part of the last thread is still visible. If it is not, fibre discs must be added by an armourer. Unscrew the buffer by half a turn if it is of the disc type, or  $\frac{1}{2}$  turns if the spring type.

5. MAINTENANCE

CLEANING AND LUBRICATION.

(a) LUBRICANTS AND THEIR USES.

(i) Oil "A"

Oil "A" is authorised for cleaning, lubricating and preserving small arms (A.C.I. 874/44). Engine oil, (e.g. Oil 30 H.D) may be used as a substitute except when the machine gun is to be fired in cold weather.

Oil "A" is authorised for cleaning, lubricating and preserving small arms (A.C.I. 874/44). Engine oil, (e.g. Oil 30 H.D) may be used as a substitute except when the machine gun is to be fired in cold weather.

Daily cleaning.  
If the machine gun is dry clean and re-oil remove the muzzle and engage the cocking handle. Insert a piece of clean loop of the cleaning rod. Dry clean the rod. Dry clean the fouling is present, examined. Re-examine of flannellette (21) to the chamber. trigger and replace.

Cleaning before  
Whenever possible stripped, clean frictional surface operation.

The bo  
The fr  
The fr  
casing  
The o  
rear  
The o  
If, through  
the bore and  
parts oiled



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(ii) Oil, mineral hydraulic buffer CS 1117B.

This oil is used as a lubricant in cold weather.

(b) CLEANING.

Equipment required:- Oil "A" (or Oil 30 H.D).  
.30" cleaning rod w/wire brush.  
Reflector barrel cal: .30.  
Tools for stripping the machine gun.  
Supply of clean rag and flannelette.  
Boiling water.

(i) Daily cleaning.

If the machine gun is clean and dry, it is necessary only to dry clean and re-oil the bore. To dry clean the bore, remove the muzzle and breech covers, open the breech and either engage the cocking handle with the breech block latch or engage the transporter with the cam on the breech casing. Insert a piece of clean flannelette (4ins x 2ins) into the loop of the cleaning rod and fold it back over the end of the rod. Dry clean the bore. If either rust or fouling is present, the gun will have to be stripped and examined. Re-oil the bore, using a well-oiled piece of flannelette (2 $\frac{1}{2}$ ins x 1 $\frac{1}{2}$ ins) paying particular attention to the chamber. Release the breech block, press the trigger and replace muzzle and breech covers.

If the machine gun has become wet or dusty, it must be stripped completely and all parts dry cleaned and re-oiled before assembling. The bore must be dry-cleaned and re-oiled and the outside of the machine gun wiped over with an oily rag.

(ii) Cleaning before action.

Whenever possible before action, the machine gun will be stripped, cleaned and inspected. The working parts and frictional surfaces will be oiled and tested for smooth operation. The following parts will be left dry:-

- The bore and chamber.
- The front of the breech block.
- The front cone and inside the front of the barrel casing.
- The outside of the barrel, except for the front and rear bearings.
- The outside of the machine gun.

If, through lack of time, the machine gun cannot be stripped the bore and chamber will be dry cleaned and the working parts oiled and tested for smooth operation.

lubricating and  
Engine oil,  
stitute except  
cold weather.



24.

(iii) Cleaning during a lull in action.

Lubricate the working parts. Cock the machine gun and lightly oil the barrel where it protrudes from the rear barrel bearing. Wipe any dirt or dust from the feed block. See also para. (c) (i) below. Clean the outside of the machine gun. Locate and remedy any faults that have been observed during firing.

(iv) Cleaning after action.

Immediately after action, and while the machine gun is still warm, fouling will be removed from the bore, chamber and face of the breech block by dry cleaning, after which the parts will be oiled to prevent corrosion.

On return to harbour or camp, the machine gun will be stripped completely and the bore washed with boiling water to remove internal fouling. First dry clean the bore and chamber. Insert the muzzle into a vessel of boiling water and pour boiling water into the chamber until the barrel is hot. When the barrel is hot, place a piece of flannelette (4 ins x 2 ins) in the loop of the cleaning rod and insert it into the chamber. With the muzzle immersed in the boiling water, use the cleaning rod as a pump to draw the water into the bore. Keeping the rod central in the bore, repeat the pumping action several times. Dry clean and inspect the bore and chamber. Repeat until the bore is clean. If boiling water is not available, wash the bore with a well oiled piece of flannelette and dry clean. Examine the bore for metallic fouling and remove it with the wire brush and cleaning rod. The wire brush will be oiled before use. If it is impossible to remove the metallic fouling in this way, the barrel will be handed over to an armourer. Thoroughly clean the threads of the muzzle and examine for distortion. Soften the carbon on the muzzle face with oil and scrape it off with a screwdriver, taking care not to scratch the barrel. Remove the carbon from the front cone and barrel casing in the same way. Dry clean and inspect all other parts. Re-oil after inspection. Re-assemble the gun and check the action to ensure that functioning and adjustments are correct. If faults have occurred during firing, determine the cause and correct if possible. When the cause cannot be determined, or if major repairs are needed, the gunner will report the performance of the gun to the armourer. During daily cleaning of the bore for the next ten days, the flannelette with which the bore has been cleaned will be closely examined for signs of sweating in the barrel. If sweating has occurred, the bore should be washed with boiling water, dry cleaned and re-oiled.

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...to lubricate  
...The  
...dry.  
...oil.  
...mineral hydraulic  
...in cold weather  
...to dispense  
...which will congeal  
...TOOLS.  
...parts will be assembled  
...are fit and serviceable  
...to prevent  
...Spares will  
...cleaning of armament  
...will be kept clean, serviceable  
...Machine gun  
...Special frame  
...Belt and drum  
...Empty case.  
...Diagrams.  
...the instructor should emphasize  
...a rapid and correct  
...bear in mind the  
...MOVEMENT.  
...barrel, barrel  
...frame.  
...the transporter, the  
...block.  
...cocked). Push the  
...MOVEMENT.  
...the barrel to the  
...of the barrel  
...the gun is  
...strikes the  
...expands in



(c) SPECIAL CONDITIONS.

(i) Sand or dust.

The working parts of the machine gun must be cleaned frequently. Lubrication should be reduced to a minimum. Wipe the parts of the machine gun with a lightly oiled cloth to prevent rust and to lubricate the machine gun during firing. Keep the outer and non-frictional surfaces of the machine gun absolutely dry. The bore should be protected by a flimsy muzzle cover.

(ii) Cold weather.

Oil, mineral hydraulic buffer CS 1117B will be used for lubrication in cold weather. If this oil is not available, it is better to dispense with all lubricants rather than use those which will congeal.

(d) SPARE PARTS AND TOOLS.

All spare parts will be assembled in the machine gun to ensure that they are fit and serviceable. When they have been tested, they will be oiled to prevent rust, and stowed in the correct place in the tank. Spares will be dry cleaned and inspected during weekly cleaning of armament and before and after action. Tools will be kept clean, serviceable and, if made of steel, lightly oiled.

6. MECHANISM

Equipment required:- Machine gun.  
Special frame (for teaching mechanism)  
Belt and drill rounds.  
Empty case.  
Diagrams.

Note: The instructor should emphasise that in this lesson he is analysing a rapid and complex action. The class must always bear in mind the high speed at which the gun fires.

(a) BACKWARD MOVEMENT.

PREPARATION.

Place the barrel, barrel extension and lock frame in the special frame. Remove the transporter, the return spring and rod from the breech block. Push the breech block forward. (The gun will be left cocked).

DEMONSTRATION.

Push the barrel to the rear.

EXPLANATION.

(i) Sealing of the breech.

When the gun is cocked and trigger is pressed, the firing pin strikes the cap and fires the round. The cartridge case expands in all directions and seals the breech.



26.

(ii) Recoil.

The pressure of gases which force the bullet out of the bore is felt equally on the face of the breech block. The barrel, barrel extension and breech block recoil as a unit for approximately half an inch. This movement is assisted by the pressure of the gases from the propellant charge which accumulate behind the front cone.

(iii) Unlocking of the breech.

The breech is not unlocked until the bullet leaves the bore. When the breech lock clears the breech lock cam (in the body of the gun) the breech lock is forced down by the breech lock pin being driven against the cam projections of the lock frame. The breech block is now unlocked from the barrel extension and continues its movement to the rear. A live round is withdrawn from the belt by the transporter and the empty case from the chamber by the breech block. The return spring is compressed during this movement.

(iv) Action of the accelerator.

The barrel extension, as it moves to the rear, compresses the barrel return spring and bears against the accelerator. The accelerator is thus rotated backwards and strikes the accelerator face in the breech block and speeds it to the rear, further compressing the return spring. The cams on the accelerator engage with the T-piece on the barrel extension and thus lock the barrel extension to the lock frame. The accelerator stop prevents the accelerator from rotating too far.

(v) Limit of backward movement.

The breech block is limited in its backward movement when it strikes the buffer in the rear plate.

(b) FORWARD MOVEMENT.

DEMONSTRATION.

Push forward the breech block.

EXPLANATION.

(i) Action of return spring.

The return spring re-asserts itself and forces the breech block forward again. During this movement, a live round, withdrawn from the belt during the backward movement, is placed in the chamber.

(25) Rotation of the accelerator and barrel extension  
The accelerator and barrel extension rotate together during firing.  
(26) Locking of the breech  
The breech lock cam and breech lock pin engage during firing.  
The breech block is locked in the firing position.  
COCKING ACTION.  
EXPLANATION.  
strip the breech block from the cocking lever and sear.  
EXPLANATION.  
As the breech block moves forward, the cocking lever is forced to the rear, thus compressing the sear spring. The sear spring pressure lever rotates on its pivot forward in the slot and finally engage with the sear.  
(3) FIRING ACTION  
FIRST SHOT.  
(i) Demonstration  
Replace the breech block to the firing position.  
(ii) Explanation  
When the breech block is moved forward, the trigger is pulled down and the breech block is locked in the firing position.  
SUBSEQUENT ACTION.  
EXPLANATION.  
When the trigger is pulled down, the breech block is locked in the firing position and the accelerator is engaged with the barrel extension.



(ii) Rotation of the accelerator.

The accelerator face on the breech block strikes the accelerator and causes it to turn forward so that the barrel extension is unlocked from the lock frame. The barrel return spring is thus able to drive forward the barrel extension and barrel.

(iii) Locking of the breech.

The breech lock is forced upwards by the breech lock cam and engages in the recess under the breech block. The breech is thus locked before the parts reach the firing position.

(c) COCKING ACTION.

PREPARATION.

Strip the breech block. Lay the firing pin, sear spring, cocking lever and sear in their relative positions.

EXPLANATION.

As the breech block moves to the rear, the upper end of the cocking lever is forced forward in the cocking lever recess in the top plate. The lower end brings the firing pin with it to the rear, thus compressing the firing pin spring against the sear spring pin. The bent of the firing pin engages with the sear. When the breech block moves forward, the cocking lever rotates on its axis pin so that its lower end moves forward in the slot of the firing pin, leaving the firing pin free to move forward at a later stage. The trigger cams finally engage with the sear when the breech is locked.

(d) FIRING ACTION

FIRST SHOT.

(i) Demonstration.

Replace the breech block in the frame. Raise the trigger to disengage the sear from the firing pin.

(ii) Explanation.

When the finger piece of the trigger is raised, the front end is lowered so that the trigger cams pull down the sear. The bent of the firing pin is thus released from the sear. The firing pin is then driven forward by its own spring.

SUBSEQUENT SHOTS.

Explanation.

When the breech block moves to the rear, the sear is disengaged from the trigger cams and moves along the trigger shaft. During this movement, the gun is cocked. As the breech block moves forward, the sear returns along the trigger shaft until it is pulled down by its cams striking the trigger cams. (Pressure has been maintained on the finger piece of the trigger). This action which releases the firing pin, is preceded by the locking of the breech.



28.

Note: If the firing pin were prematurely released, it would move forward under control of the cocking lever so that the round would not be fired until the breech was locked.

(e) ACTION OF FEED.

DEMONSTRATION.

(i) Movement of feed lever.

Open the cover and place the nose of a drill round in the feedway of the breech block and against the edge of the top plate to represent the stud of the feed lever. Pull back the cocking handle and then ease it forward.

(ii) Action of the transporter.

Load the gun, open the cover, press down on the transporter, pull the cocking handle to the rear and then ease it forward.

EXPLANATION.

Note: The movement of the feed lever and the action of the transporter are simultaneous. They are treated separately for the sake of simplicity.

Movement of the feed lever.

As the breech block moves to the rear, the stud of the feed lever is moved to the right by the feedway on the breech block. This causes the feed pawl and slide to move to the left and engage behind the next round in the belt. During this movement the retaining pawl holds the belt in position. When the breech block moves forward, the feedway causes the feed lever stud to move in the opposite direction, thus causing the slide and feed pawl to move to the right. This action places the first round in the belt against the cartridge and bullet stops. The round is now ready to be gripped by the transporter. During this action, the retaining pawl has been depressed by the belt passing over it.

Action of the transporter.

As the breech block moves to the rear, the transporter withdraws a live round from the belt, and the breech block brings an empty case from the chamber. As the breech block moves fully to the rear, the ramp on the underside of the cover forces the transporter down and places the live round in line with the chamber and engages the rim of the cartridge case in the guides on the face of the breech block. The empty case, if it has not previously fallen off, will be forced off by the ejector. As the breech block moves forward, the transporter, moving along the top of the barrel extension, carries the round forward into the chamber. The transporter is now driven up by the front cam and the claw of the transporter released from the round now in the chamber. The upward movement of the transporter is limited by the transporter spring in the cover which also ensures that the transporter claw engages with the round in the feed block.



Action of the feed pawl extension.

If the round is not withdrawn from the belt, double feed is prevented by the action of the feed pawl extension which rides over the round and disengages the feed pawl from the belt.

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30.

SECTION 4. - SMOKE WEAPONS.

1. BOMB-THROWER 2-in. Mk. 2.

Equipment required :- Bomb-thrower, 2" Mk. 2 mounted in an A.F.V. or on instructional mounting.

(a) INTRODUCTION.

NAME.

Bomb-thrower 2-in. Mk. 2.

WEIGHT.

CALIBRE.

2 inches.

MUZZLE VELOCITY.

RANGE. (using 55 grain cartridge).

Short - 25 to 50 yards.  
Medium - 125 to 150 yards.  
Long - 300 to 450 yards.

OPERATION.

The bomb-thrower is loaded by hand with a 2" bomb containing a ballistite cartridge in the tail unit. When the firing knob is struck, the firing pin strikes the cap of the cartridge and ignites the propellant. The pressure of the propellant gases drives the bomb through the bore.

The range of the bomb-thrower can be varied according to the setting of the gas regulator sleeve which is marked L (long), M (medium) and S (short). When the regulator is set at L, the full pressure of the gases is exerted against the bomb. When the regulator is set at M or S, a proportion of the gases is by-passed through ports cut in the barrel and inner sleeve of the regulator. The gases escape through an annular space between the inner and outer sleeves of the gas regulator, into the barrel and finally out of the muzzle.

AMMUNITION.

Bomb, ML 2" bomb-thrower Mk. 1.  
Bomb, smoke bursting 2" bomb thrower WP Mk. 3.

(b) HANDLING.

TO MOUNT THE BOMB-THROWER.

Equipment required :- Spanner 1/2" x 9/16".  
"C" spanner.

- (i) Remove the four bolts from the mounting.
- (ii) Slacken the breech ring locking nut and ensure that the breech ring is screwed up to the stop on the barrel.
- (iii) Adjust the breech ring so that the carrier hinge pin will be at a 9 o'clock position when the thrower is mounted. Tighten the locking nut.



31.

- (iv) Ensure that the barrel guide in the mounting is clear.
- (v) Insert the barrel about half way into the mounting and support the bomb-thrower.
- (vi) Engage the four bolts with the slots in the barrel flange and push the bomb-thrower into the mounting until the bolts can be screwed into the threaded holes in the mounting.
- (vii) Tighten each bolt in turn until the bomb-thrower is held securely by all four bolts.

TO LOAD.

- (i) Rotate the actuating lever to the left to open the breech.
- (ii) Insert the bomb nose first so that the tail fins pass under the bomb-retaining catch.
- (iii) Close and lock the barrel.

The drill for using the two types of bombs is that the screen is begun with WP to give immediate screening, followed at once by HCE and then another WP. The screen is maintained with HCE and casual gaps are filled with WP.

TO FIRE.

- (i) Set the gas regulator at the required range.
- (ii) Fire by striking the firing pin knob.

Note :- The breech must be fully locked before the firing pin can be driven forward.

TO UNLOAD.

- (i) Open the breech.
- (ii) Lift the bomb retaining catch and grasp the bomb as it slides back.
- (iii) Close the breech.

(c) STRIPPING AND ASSEMBLING.

Equipment required :- Large screwdriver.  
Small screwdriver.  
"C" spanner.

TO REMOVE THE STRIKER CASE FROM THE CARRIER.

- (i) Open the breech.
- (ii) Turn each retaining pin through 180 degrees so that the punch marks on the screws are in line with the scribe-mark on the carrier.
- (iii) Release the actuating lever safety catch and move the safety lug clear of the striker knob.
- (iv) Push the striker case out of the carrier.
- (v) Assemble in the reverse order.

TO STRIP THE STRIKER CASE.

- (i) Remove the firing pin knob securing screw and the knob.
- (ii) Slacken the firing hole bush retaining screw approximately four turns and remove the bush from the striker case.
- (iii) Remove the firing pin and spring.
- (iv) Assemble in the reverse order.

TO REMOVE THE GAS REGULATOR.

- (i) Slacken the breech ring locking nut, remove the breech ring (right hand thread) and the nut.
- (ii) Remove the regulator locking nuts.
- (iii) Slide the regulator off the barrel.
- (iv) Assemble in the reverse order.



32.

(d) TEST.

GAUGING THE PROTRUSION OF THE STRIKER.

Equipment required :- Gauge, striker protrusion No. 42.

- (i) Open the breech.
- (ii) Press in the actuating lever locking catch and rotate the actuating lever clear of the firing knob.
- (iii) Press the firing knob and firing hole bush together to ensure maximum protrusion of the firing pin.
- (iv) Slide the gauge over the firing pin at right angles to the bush. The minimum step should foul the firing pin and the maximum clear it.
- (v) If the firing pin fails to gauge, report to an armourer.

(e) MAINTENANCE.

CLEANING AND LUBRICATION.

(i) Before firing.

Dry clean the barrel and inner sleeve, the firing pin head and bush.  
Oil the breech mechanism.  
Replace the muzzle cover to prevent dirt and moisture entering.

(ii) After firing.

Remove the bomb-thrower from its mounting.  
Dry clean and re-oil all parts especially the gas ports, firing pin hole and bush.

INSPECTION.

Examine the barrel, gas ports and inner sleeve for fouling.  
Examine the breech mechanism for burrs and damage.

(f) DEFECT .

The Mk3 WP bomb should be fired ONLY at LONG range owing to the failure of the fuze No. 151 to arm at lower ranges.

2. BOMB-THROWER 2-in. Mk. 1/2.

Equipment required :- Bomb-thrower 2-in. Mk. 1/2 mounted in an AFV or on an instructional mounting.

(a) INTRODUCTION.

NAME.

Bomb-thrower, 2-in. Mk. 1/2.

WEIGHT.

16 $\frac{3}{4}$  lb.

CALIBRE.

2 inches.

MUZZLE VELOCITY.



33.

RANGE (using 18 grain cartridge).

Short	-	20 yards.
Medium	-	70 yards.
Long	-	110 yards.

OPERATION.

The bomb-thrower is loaded by hand with a 2" bomb containing a ballistite cartridge in the tail unit. When the trigger is pressed, the firing pin strikes the cap and is immediately withdrawn. The pressure of the propellant gases drives the bomb through the bore. The range of the bomb-thrower can be varied by the gas reulator consisting of a valve which, subject to the setting of the lever on the valve casing, allows a proportion of the gases to escape into the turret. The gases have no ill effect on the crew. A safety rod linked to the trigger engages in the junction nut to ensure that the bomb-thrower cannot be fired unless the junction nut is locked.

AMMUNITION.

Bomb, ML 2" bomb-thrower Mk. 1.  
Bomb, smoke bursting 2" bomb-thrower WP Mk. 3.

Note :- 18 grain cartridges will be used with this bomb-thrower since the jubilee clip securing the regulator is NOT strong enough to withstand the 55-grain cartridge. The clip is being replaced by a U-bolt.

(b) HANDLING.

TO MOUNT THE BOMB-THROWER.

Equipment required :- Spanner 1/2" x 9/16".

- (i) Remove the four bolts from the mounting.
- (ii) Insert the bomb-thrower into the sleeve fitted into the turret roof and replace the bolts.

Note :- For convenience, the front barrel (detached from the rear barrel by removing the hinge pin) may be mounted first and the rear barrel then attached to it.

TO LOAD.

- (i) Rotate the junction nut to the left and lower the rear barrel.
- (ii) Remove the cap from the bomb (if Mk. 3 WP) and insert the bomb nose first into the FRONT barrel.
- (iii) Raise the rear barrel, ensuring that it does not foul the fins of the bomb.
- (iv) Check that the bomb slips back into the rear barrel and rotate the junction nut.

THIS DRILL WILL BE ENFORCED AS ACCIDENTS HAVE BEEN CAUSED BY LOADING THE BOMB INTO THE REAR BARREL.

TO FIRE.

Press the trigger.

TO UNLOAD.

- (i) Open the breech.
- (ii) Lift out the bomb by its tab, if fitted, and close the breech.
- (iii) If no tab is fitted, remove the rear barrel, tip out the bomb and replace the rear barrel. Close the breech.



34.

(c) MAINTENANCE.

CLEANING AND LUBRICATION.

(i) Before firing.

Dry clean the front and rear barrels and lubricate the junction nut and hinge pin.  
Test the action of the trigger. If the firing pin protrudes after releasing the trigger, remove the left side plate from the pistol grip and examine for damage and obstruction. Replace the muzzle cover to prevent dirt or moisture entering.

(ii) After firing.

Remove the bomb-thrower from its mounting.  
Dry clean and re-oil all parts especially the firing pin hole and bush.

(d) DEFECTS.

The jubilee clip securing the gas regulator is NOT strong enough to allow 55-grain cartridges to be fired. 18-grain cartridges will, therefore, be used.

3. REAR SMOKE EMITTERS.

(a) DESCRIPTION.

Two smoke generators (No. 8 Mks. 5 or 6) are fitted into each of two metal containers at the rear of the vehicle. Each pair of generators is fired electrically by switches in the driver's compartment.

(b) USE.

TO FIT THE GENERATORS.

- (i) Open the containers and insert two generators into each.
- (ii) Close the containers and connect one electrical lead from each generator to each terminal.

TO FIRE.

Press the firing switch.

(c) MAINTENANCE.

CLEANING AFTER FIRING.

- (i) Remove the spent canisters and clean the metal containers.
- (ii) Remove all carbon and the remains of the electrical leads.



# SECTION 5 - THE GUN MOUNTING.

Equipment required: Guns and mounting in an APV or on an instructional appliance.  
Field clinometer Mk. 6.  
Mounting tools (SEE APPENDIX "A")  
Diagram of the recoil system.  
Injector oil or petrol.  
Junior compressor.  
Oil CS 1117E.  
Oil 30 HD.  
Grease No. 1.

## 1. INTRODUCTION.

The 17-pr gun and .30" Browning co-axial machine gun are supported in the Mounting No. 1 or No. 1A Mk. 1.

The No. 1 has a Mk. 1 recoil buffer and the No. 1A a Mk. 2 recoil buffer

The machine gun mounting and telescope mounting are separate components but, in their vertical movements are synchronised by linkage, with the 17 pr. gun.

## 2. THE 17-PR MOUNTING.

### (a) THE CRADLE.

#### Object.

To support the 17-pr gun and recoil system.

#### DESCRIPTION.

The centre of the cradle is a steel cylinder with bronze liners through which the gun slides on recoil and run-out. The cradle is carried by means of two trunnions on bearings in the turret nosepiece and is secured by cap squares and bolts. A gun travelling lock is attached to the top rear of the cradle. Two lubricators are provided for each trunnion bearing and four for the gun slides (2 each side).

#### MAINTENANCE.

Keep the cradle clean and lightly oil the unpainted steel parts with Oil 30 HD.  
Lubricate the gun slides and trunnion bearings with Grease No. 1.

### (b) THE MANTLET.

#### Object.

To protect the front of the cradle by masking the gun aperture in the nosepiece at all angles of elevation and depression.

#### DESCRIPTION.

The mantlet, made of armoured steel, is bolted to the front of the cradle by eight bolts and fits closely around the gun barrel. The front face is shaped to deflect bullet splash which may enter through the gun aperture. A hole through the upper part of the right side of the mantlet gives access to the buffer control valve.



36.

MAINTENANCE.

Check for tightness the eight bolts which secure the mantlet to the cradle.

(c) THE SEMI-AUTOMATIC GEAR.

Object.

To open the 17-pr breech during run-out.

DESCRIPTION.

The gear consists of a fabricated bracket containing the SA cam, plunger and spring and is secured to the cradle by four bolts and two locating dowels. The cam pivots on a bronze bearing and a fulcrum pin in the lower part of the bracket. Two nipples in the top of the bracket provide a means of lubricating the plunger and spring and one nipple on the underside of the cam for lubricating the cam pivot. On the inside of the bracket, above the cam spring housing, is a slot for the anti-rotation key of the breech ring. Two lubricating holes are provided in the upper side of the slot.

USE.

The cam is normally set at SA and is kept there by the cam spring and plunger.

To set the gear at Q.F., e.g. when firing reduced charge ammunition, rotate and withdraw the locking pin from the upper hole in the bracket. Depress the cam, insert the locking pin in the lower hole and ensure that the pin is retained by the flanged stud on the bracket.

MAINTENANCE.

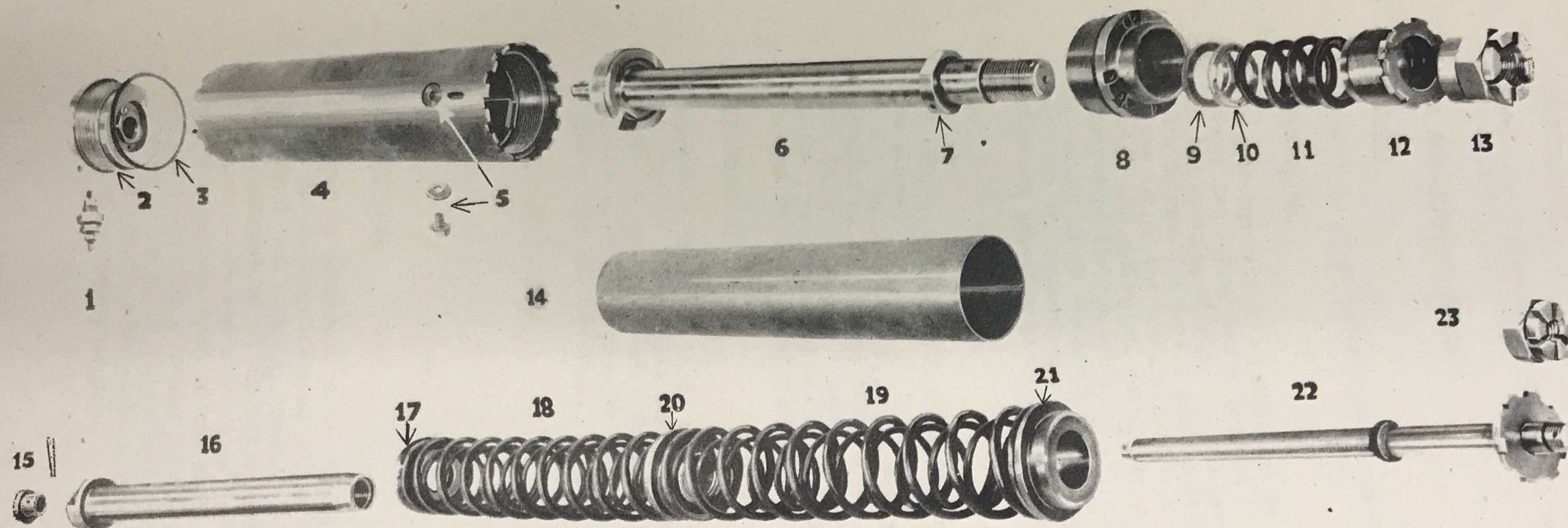
Check that the four bolts securing the bracket to the cradle are tight. Ensure that the cam pivot pin is securely pinned. Lubricate the anti-rotation key guideway with Oil 30 HD and the cam spring and plunger and cam pivot with Grease No.1. Lightly oil the cam body.

(d) THE ELEVATING GEAR.

DESCRIPTION.

The gear is attached to the cradle by a connector pin and consists of an internally threaded sleeve which, through the medium of a handwheel and gearing, travels up or down a screwed rod, according to the direction in which the handwheel is rotated. The handwheel is marked with lines denoting  $1/16$ ths and dots denoting  $1/32$ nds of one complete turn of the wheel. The marks are used in conjunction with a reader bolted to the gear housing. Each  $1/16$ th is equal to approximately 4 minutes elevation. The screwed rod is secured to a bracket on the turret floor by means of a connector pin.





#### ITEMS 1-13 BUFFER.

1. BUFFER CONTROL VALVE.
2. CONTROL VALVE BODY.
3. OIL SEAL.
4. BUFFER CYLINDER.
5. FILLING HOLE AND PLUG W/WASHER.
6. PISTON.
7. STOP FLANGE.
8. STUFFING BOX WITH OIL SEAL IN POSITION.
9. SUPPORTING RING.
10. WHITE METAL HEADER RING.
11. CHEVRON PACKING.
12. PACKING GLAND.
13. NUT SECURING GUN TO BUFFER.

#### ITEMS 14-23 RUNNING-OUT PRESSER.

14. SPRING CASE.
15. END CAP W/TAPER PIN.
16. COMPRESSING SLEEVE.
17. FRONT BEARING RING.
18. RECUPERATOR SPRINGS INNER AND OUTER FRONT.
19. RECUPERATOR SPRINGS INNER AND OUTER REAR.
20. SPACER.
21. THRUST RING.
22. COMPRESSING ROD.
23. NUT SECURING GUN TO RECUPERATOR.

#### RECOIL SYSTEM

FIG. 3.

AFVP/DP/853.

DECLASSIFIED  
Authority NND 735004

To test for backlash

1. Insure that all
2. Release the travel
3. One member of the
4. near as possible
5. barrel upwards
6. Set the field
7. the breech ring
8. Level the gun
9. When the gun is
10. level and ho
11. outside will
12. The gunner will
13. meter by mean
14. If the readi
15. further.

Check and ins  
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Examine the scr  
present, will  
lubrication.

Top up the gun  
the nipples w  
RECOIL SYSTEM.

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the out in the  
the cylinder w  
the gun by means  
the range given and  
the range for 10 div  
the gun  
the last three or four  
the gun is on the  
right of the gun



37.

The gearing is contained in a housing which is provided with a filler plug, drain plug and oil seals. Two lubricating nipples are fitted to the gear housing and one to each connector pin.

#### USE.

When laying the gun by means of the handwheel markings, the gunner will take up any backlash in the gears as follows:-

When elevating, the gunner will turn two or three divisions beyond the range given and then return to the correct handwheel marking. For example, on the order "Up 8" he will elevate for 10 divisions and depress slowly 2 divisions. When depressing, the gunner will turn the handwheel slowly for the last three or four divisions to ensure that the weight of the gun is on the gears.

#### TEST

To test for backlash.

1. Ensure that all mounting bolts are tight.
2. Release the travelling lock and traverse to 6 o'clock.
3. One member of the crew, standing on the hull and as near as possible to the gun muzzle, will pull the gun barrel upwards without undue force.
4. Set the field clinometer to zero and place it on the breech ring with the bubble arm pivot to the rear.
5. Level the gun against the upward pull.
6. When the gun is level, the gunner will shout "Gun level" and hold the handwheel firmly. The man outside will push down and hold the barrel.
7. The gunner will centralise the bubble of the clinometer by means of the slider and note the reading.
8. If the reading exceeds 10 minutes, report to a gunfitter.

#### MAINTENANCE

##### Checking and inspection.

Ensure that the connector pin set screws and all nuts and bolts on the gear housing and bracket are tight.

Examine the screwed rod cover for dents which, if present, will be removed by a gunfitter.

##### Lubrication.

Top up the gear housing with Oil 30 HD and lubricate the nipples with Grease No. 1.

#### (e) THE RECOIL BUFFER.

##### Object.

To dissipate recoil energy and buffer the gun during run-out.

##### DESCRIPTION. (See Figure 3.)

The buffer consists of a cylinder containing oil, a piston and a control valve. Either a Mk. 1 or a Mk. 2 buffer may be fitted. In the Mk. 1 buffer, the oil passes through a slot cut in the piston; in the Mk. 2, through 4 grooves cut in the cylinder wall. The recoil energy is absorbed gradually by controlling the oil flow. In the Mk. 1 buffer the flow is controlled by a tapered key fitted in the cylinder

ITEMS 14-23 RUNNING-OUT PRESSER.

14. SPRING CASE.  
15. END CAP W/ TAPER PIN.  
16. COMPRESSING SLEEVE.  
17. FRONT BEARING RING.  
18. RECUPERATOR SPRINGS INNER AND OUTER REAR.  
19. RECUPERATOR SPRINGS INNER AND OUTER REAR.  
20. SPACER.  
21. THRUST RING.  
22. COMPRESSING ROD.  
23. NUT SECURING GUN TO BUFFER.

ITEMS 1-13 BUFFER.

1. CONTROL VALVE.  
2. OIL SEAL.  
3. BUFFER CYLINDER.  
4. FILLING HOLE AND PLUG W/ WASHER.  
5. STOP FLANGE.  
6. SUPPORTING RING.  
7. WHITE METAL HEADER RING.  
8. CHEVRON PACKING.  
9. PACKING GLAND.  
10. NUT SECURING GUN TO BUFFER.

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8. CHEVRON PACKING.  
9. PACKING GLAND.  
10. NUT SECURING GUN TO BUFFER.



38.

which throttles the slot in the piston as the piston is drawn through the cylinder and in the Mk. 2 by decreasing the depth of the grooves towards the rear of the cylinder.

The cylinder, which is attached to the cradle, is closed at the front end by the control valve body and at the rear end by the piston rod and a packing and gland. The cylinder contains approximately  $7\frac{1}{2}$  pints of oil.

The control valve body is screwed into the front of the cylinder against an oil seal. It contains a bushed chamber, a by-pass drilling and an adaptor with an adjustable needle valve. The needle is seated in the by-pass drilling to control the rate at which the oil flows from the chamber and buffer the last few inches of run-out.

The piston is an oil tight fit in the cylinder and is secured to the gun lug by the nut securing gun to buffer. A plunger extension on the front of the piston head engages with the chamber in the control valve body when the gun is in the run-out position.

#### MAINTENANCE.

##### (i) To adjust the buffer control valve.

1. Ensure that the control valve adaptor is tight.
2. Slacken the valve locking nut three turns.
3. Tighten the valve without force.
4. Slacken the valve  $\frac{1}{8}$ th of a turn.
5. Hold the valve and tighten the valve locking nut.

##### (ii) To fill and top up the buffer.

1. Fully depress the gun and remove the filling plug.
2. Pour in oil CS 1117B slowly to prevent formation of air bubbles.
3. When the cylinder is full (the level of oil can be seen with the use of a periscope object prism), replace the filling plug.
4. Elevate and depress the gun three or four times.
5. Depress the gun, remove the filling plug and top up to fill the cylinder.
6. With the syringe, withdraw  $\frac{3}{8}$ th of a pint ( $3\frac{3}{4}$  measures) of oil from the cylinder.
7. Replace the filling plug, ensure that the oil seal is in position and tighten the plug.
8. Adjust the control valve.

##### (iii) Checking for security and leaks.

1. Ensure that the nut securing gun to buffer is tight and pinned.
2. Examine the cylinder for leaks. If leaks are found, report to a gunfitter.

#### MAINTENANCE.

##### (i) Checking for security.

Ensure that the bottom rear of the gun is tight and pinned.

##### (ii) Pulling back.

Periodically pull the gun. approved but

#### FAULT DIAGNOSIS

The following table is in the system.

Symptom.
Recoil violent and excessive.
Run-out violent
Run-out along
Failure to fire by a large



(f) THE RUNNING-OUT PRESSES.

Object.

To assist in absorbing recoil energy, and to return the gun to the run-out position.

DESCRIPTION.

Two running-out presses are mounted in the lower part of the cradle. Each press consists of four springs, two inner and two outer, located at the outer ends by a flange and separated by a spacer ring. The springs are held under initial compression by a rod on which they are assembled with the flanges and spacer. Each assembly is enclosed in a tubular case which is located in the cradle by a screw. The rear end of each rod is secured to the breech ring by a nut and split pin. As the gun recoils, the compression rods are drawn back to compress the springs between the rear of the cradle and the front flanges. At the end of recoil, the springs re-assert themselves and drive the gun forward.

MAINTENANCE.

(i) Checking for security.

Ensure that the six bolts holding the thrust plate on the bottom rear of the cradle are tight.  
Ensure that the nuts securing the presses to the gun are tight and pinned.

(ii) Pulling back the gun.

Periodically test the action of the springs by pulling back the gun. An apparatus for pulling back the gun has been approved but NOT yet issued.

FAULT DIAGNOSIS

The following table is a guide to diagnosing possible faults in the system.

Symptom.	Cause.	Remedy.
Recoil violent and excessive.	Lack of oil.	Top up.
	Weak or broken running-out springs.	Report to gunfitter.
	Worn piston.	Report to gunfitter.
Run-out violent	Lack of oil.	Top up.
	Buffer control valve open too much.	Adjust the valve.
Run-out sluggish	Weak running-out springs.	Report to gunfitter.
	Buffer control valve closed too much.	Adjust the valve.
Failure to run out by a large amount.	Broken running out springs.	Report to gunfitter.
	Obstruction in the gun slides or spring cases	Report to gunfitter.
	Distortion of cradle	Report to gunfitter.
	Tight buffer piston.	



(g) THE FIRING GEAR.

DESCRIPTION.

(i) Electrical.

The firing switch is mounted in the handle of the elevating handwheel and is operated by finger pressure. Two warning lamps, one for the gunner and the other for the loader, are wired in the circuit and light up when the loader's safety switch is set to "ON". The loader's safety switch, mounted on the right rear of the cradle, is a combined main and tripping switch. When the switch is ON, the warning lights are lit, and at the same time, the retaining lever rides down the latch and sets the trip to prevent the main switch being put off. Before the gun fires. When the gun has fired, the trip shaft causes the trip lever to pivot upwards against the trip and break the electric circuit. An adjustable contact screw secured by a locking nut is fitted to the trip. The solenoid is mounted in a box on the left of the gun mounting.

The warning lamps are wired in parallel with each other but in series with the solenoid. When in circuit, the two lamps will not pass sufficient current to operate the solenoid. On pressing the firing switch, the warning lights are extinguished so that the solenoid is allowed to operate.

(ii) Mechanical.

If the electrical firing gear fails, the gun may be fired mechanically by foot.

The firing pedal pivots in a bracket which is bolted to the floor of the turret. When not in use, it can be raised to an upright position where it is retained by a ball plunger.

The inner cable is attached to the pedal bracket and to the bell crank lever which is mounted in a bracket on the cradle.

The outer cable adjuster is attached to the firing cylinder on the cradle while the other end is attached to the firing pedal.

The push rod mounted in the selector bracket is actuated by the bell crank lever.

The selector gear consists of a lugged pin which, when rotated by a handle on the bracket, bears against one of two levers mounted on a torsion rod. When the handle is in the upright position, the selector is set for 17-pr firing, and when in the downward position, for machine gun firing. In the intermediate position the firing gear is at "SAFE".

The 17-pr gun firing lever is the upper of the two mounted in the selector bracket. It is secured to the torsion rod by flats and an Allen screw and when actuated by the lever, lugged pin of the selector gear, rotates the rod and trip lever.

... (Electrical) ...  
... that the gun is and ...  
... the master switch ...  
... lights are ON. ...  
... the firing gear ...  
... the trip lever does NOT ...  
... to an electrician. ...  
... the trip lever moves (1. ...  
... mechanism is operating ...  
... adjust the trip mechanism ...  
... the safety switch ...  
... the trip adjusting ...  
... the trip. ...  
... Adjust the screw until ...  
... it may be one-third of ...  
... test the firing gear ...  
... If the gun still fails ...  
... one-third of a turn ...  
... If the gun still fails ...  
... test and adjust the ...  
... required :-  
... Selector mechanism. ...  
... To test. ...  
... Move the selector ...  
... If the selector ...  
... To adjust. ...  
... Slacken the locking ...  
... the selector can ...  
... Firing gear. ...  
... To test. ...  
... Cock the gun, ...  
... To adjust. ...  
... Slacken the ...  
... will fire. ...  
... free movement.



41.

The trip lever actuates the firing rod and levers on the breech ring.

# TESTS AND ADJUSTMENTS.

## (i) To test (electrical).

1. Ensure that the gun is unloaded.
2. Switch on the master switch.
3. Cock the gun.
4. Depress the safety switch handle to ON and note whether the warning lights are ON.
5. Watch the firing gear trip lever and press the finger switch.

If the trip lever does NOT move (i.e. the solenoid is not energised) report to an electrician.

If the trip lever moves (i.e. the solenoid is energised) the safety trip mechanism is operating too soon and requires adjustment.

## (ii) To adjust the trip mechanism.

1. Depress the safety switch handle to ON, slacken the locking nut on the trip adjusting screw and turn the screw until it clears the trip.
2. Adjust the screw until it touches the trip lever and then turn it away by one-third of a turn (two flat sides of the head).
3. Re-test the firing gear.
4. If the gun still fails to fire, turn the screw away by another one-third of a turn and re-test.
5. If the gun still fails to fire, report to a gunfitter.

## (iii) To test and adjust the mechanical firing gear.

Equipment required :-      Spanner  $\frac{1}{4}$ "  
   Spanner  $\frac{3}{8}$ ".

### 1. Selector mechanism.

#### To test.

Move the selector to each of the three positions in turn.  
If the selector jams during movement, adjust the firing cable.

#### To adjust.

Slacken the locking nut and loosen the adjusting screw until the selector can be moved easily.

### 2. Firing gear.

#### To test.

Cock the gun, set the selector to 17-pr. and press the trigger.

#### To adjust.

Unscrew the adjusting screw on the firing cable until the gun will fire. Tighten the locking nut and check the selector for free movement.



### 3. THE MACHINE GUN MOUNTING.

#### Object.

To hold the machine gun rigid and to mask the machine gun aperture at all angles of elevation and depression.

#### (a) DESCRIPTION.

- (i) The cradle consists of two lengths of tubular steel and two bracing angles secured to an end plate. The end plate is drilled for attachment to the mantlet. A gun swivel is secured to the cradle by a self-locking nut and is provided with a gun fixing pin. At the rear of the cradle is the elevation bracket. The bracket is made in the form of a clamp to hold the elevating joint, adjusting head and locking nut. The elevating joint is provided with a fixing pin similar to that in the gun swivel. The gun is positioned laterally by two screws with locking nuts. Secured to the cradle is the cartridge chute and ammunition box carrier. A spring loaded cocking handle guard is fitted to the right side of the cradle. The rear of the cradle is secured to the SA bracket by three bolts. The linkage is spring loaded and provided with two lubricators.
- (ii) The cartridge case chute is secured to the underside of the cradle. It has five press studs for attaching the empty case bag.
- (iii) The ammunition box carrier is mounted forward of the chute and is pivoted to assist in ritting the ammunition box. The carrier is secured in the closed position by a spring catch. A roller on the top edge of the carrier assists in feeding the belt during firing.
- (iv) The mantlet is an armoured steel casting pivoted in the nosepiece on a steel pin and bronze bushes. The pin is bored across its axis to receive the barrel casing of the machine gun and is provided with a lubricator. The mantlet is secured to the cradle by four bolts.
- (v) The firing gear consists of a lever pivoted in the elevating joint and a Bowden cable. The rear end of the lever is situated directly under the finger piece of the machine gun trigger, while the forward end of the lever extends under the gun body. The forward end of the lever is vertically drilled and slotted for the attachment of the firing cable, while the rear end has an adjustable stud which contacts the gun trigger finger piece. The firing cable is attached at one end to the firing lever, and at the other end to the M.G. firing lever in the selector bracket on the 17-pr gun mounting. One end of the cable casing is attached to the machine gun cradle by means of a threaded sleeve and the other end is seated in the selector bracket.

...the cocking handle gun  
...the barrel guide  
...the barrel stop screws.  
...the barrel casing of  
...the gun body  
...the gun fixing pins.  
...the transverse stop  
...the elevating  
...the cocking handle  
...the empty case bag.  
...THE AMMUNITION BOX.  
...press the catch on the  
...insert the ammunition box  
...action).  
...first the carrier to the  
...THE MACHINE GUN.  
...required:- Spanner  
...Spanner  
...remove the empty case bag  
...loosen the transverse  
...remove the gun fixing  
...lift the gun from the  
...replace the gun fixing  
...gun swivel.  
...AND ADJUST THE FIRING  
...required:- Spanner  
...Spanner  
...to test.  
...ensure that the gun is  
...the selector to M.G.  
...machine gun fails to  
...adjust.  
...the machine gun  
...the firing lever  
...the firing lever



43.

(b) USE

TO MOUNT THE MACHINE GUN

Equipment required:- .30" Browning machine gun.  
Bag, empty cartridge case.  
Spanner 1/4" x 3/16"  
Spanner 3/8" x 5/16"  
Spanner adjustable, 11".

- (i) Lower the cocking handle guard and remove the gun fixing pins.
- (ii) Ensure that the barrel guide is clear and slacken the transverse stop screws.
- (iii) Insert the barrel casing of the machine gun into the barrel guide, lower the gun body on to the cradle and insert and secure the gun fixing pins.
- (iv) Tighten each transverse stop screw until it just contacts the gun body.
- (v) Ensure that the elevating joint locking nut is tight.
- (vi) Raise the cocking handle guard.
- (vii) Fit the empty case bag.

TO FIT THE AMMUNITION BOX.

- (i) Depress the catch on the ammunition box carrier.
- (ii) Insert the ammunition box (first removing the lid during action).
- (iii) Pivot the carrier to the left.

TO DISMOUNT THE MACHINE GUN.

Equipment required:- Spanner 1/4" x 3/16".  
Spanner 3/8" x 5/16".

- (i) Remove the empty case bag.
- (ii) Slacken the transverse stop screws.
- (iii) Remove the gun fixing pins.
- (iv) Lift the gun from the mounting.
- (v) Replace the gun fixing pins in the elevating joint and gun swivel.

(c) MAINTENANCE.

TO TEST AND ADJUST THE FIRING GEAR.

Equipment required:- Spanner 1/4" x 3/16".  
Spanner 3/8" x 5/16".

(i) To test.

Ensure that the gun is securely mounted and that the firing gear is correctly assembled. Cock the machine gun, set the selector to M.G. and press the trigger. If the machine gun fails to fire the firing gear requires adjustment.

(ii) To adjust.

Slacken the adjusting stud of the firing lever. Cock the machine gun and adjust the stud until it just contacts the finger piece of the gun trigger. Re-test. If the gun fails to fire, report to an armourer.



44.

#### 4. TELESCOPE MOUNTING

The telescope is held in a **carrier** which is mounted in the sight mantlet. The mantlet pivots on trunnion pins contained in the nose plate and is connected by a link bar to the left gun trunnion to synchronise the movement of the telescope and the gun. There are two types of telescope brackets, as described below.

(a) **STANDARD TYPE** ( for use with No. 43 x3 ML Mk. 3 telescope.)

##### DESCRIPTION

- (i) The telescope carrier is a cylindrical casting which contains the telescope sleeve. Four adjusting screws with locking nuts or rings are set around the rear of the bracket. The screws are inclined forward and bear against four seatings on the telescope sleeve. A projection in the carrier engages with the sleeve to prevent rotation. A clamp at the rear of the carrier holds the brow-pad bracket.
- (ii) The telescope sleeve within the mounting is a light alloy cylinder with a hinged clamp at the rear to secure the telescope. Four bevelled inserts screwed to the sleeve form seatings for adjusting screws. The telescope is positional in the sleeve by a key-way cut in the bore of the sleeve.
- (iii) The brow-pad is supported on an adjustable bracket. Two clamps tightened by vice-pins hold the pad and bracket after adjustment.

##### USE.

- (i) To mount the telescope.
  1. Slacken the brow-pad bracket clamp.
  2. Rotate the brow-pad to the left.
  3. Undo the clamp at the rear of the telescope sleeve.
  4. Insert the telescope, align the key on the telescope with the key-way in the sleeve and push the telescope fully forward. Tighten the clamp.
  5. Fit the illuminating attachment by pressing the plunger and sliding the attachment along the key-way on the graticule box.
  6. Adjust the browpad.
- (ii) To dismount the telescope.

Dismount the telescope in the reverse order.

##### MAINTENANCE

- (i) Checking and inspection.
  1. Check for tightness the bolts securing the telescope mounting to the mantlet.
  2. Ensure that the lug on the underside of the mantlet is securely attached to the link bar and that the link bar is secured to the sight lever (connecting pin and split pin).
  3. Examine the sight aperture in the mantlet for damage or obstruction.

Remove the telescope.  
Adjusting screws fully.  
Grease No. 1.  
Grease the nipple on the  
Type over all unpainted  
oil-can (Oil 30 H.D.).  
(For use with No. 43 x3 ML)

The carrier is a bronze cy-  
linder with a clamping sleeve. The  
carrier has a feather way and supportin-  
g and of the cylinder is  
flanged for attachment  
internally to r-  
the top of the rear end  
which engages with a  
release pawl withdraws  
is unlatched and retains  
a short cylinder external-  
flange to facilitate rotat-  
the telescope holder, a cone  
the clamping sleeve and  
the squeezed between the for-  
near to clamp the telescope.  
clamping sleeve is situated i-  
cylinder having a feath-  
of the clamping he-  
and the clamping head r-  
prevents the telescope movi-

Brow-pad bracket is cranked  
graticule telescope

To mount the telescope.  
1. Slacken the brow pad  
2. Rotate the brow pad  
3. Unscrew the brow pad  
4. Loosen the clamping  
5. Align the holder  
6. Insert the feather  
7. Tighten the clamping  
8. Fit the illuminat-  
9. Plunger and slid-  
10. Adjust the brow-



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(ii) Cleaning and lubrication.

1. Remove the telescope sleeve (by slackening off all adjusting screws fully) and clean.
2. Grease the spherical end of the sleeve lightly with Grease No. 1.
3. Grease the nipple on the mantlet (Grease No. 1).
4. Wipe over all unpainted steel surfaces with an oily rag.
5. Lubricate the threads of the adjusting screws with an oil-can (Oil 30 H.D).

(b) EARLY TYPE. (for use with No. 43 x3 ML Mk. 1 telescope).

DESCRIPTION.

The telescope carrier is a bronze cylinder, the upper half of which forms a clamping sleeve. The lower half of the cylinder contains a feather way and supporting surfaces for the telescope. The forward end of the cylinder is coned internally, while the rear end is flanged for attachment to the mantlet by three bolts, and threaded internally to receive the clamping head. Mounted in the top of the rear end is a spring loaded clamp release pawl which engages with a slot in the clamping sleeve. The release pawl withdraws the clamping sleeve when the telescope is unclamped and retains the sleeve. The clamping head is a short cylinder externally threaded and provided with a milled flange to facilitate rotation by hand. When screwed into the telescope holder, a coned surface on its forward end contacts the clamping sleeve and drives it forward. The sleeve is thus squeezed between the forward coned surface and that at the rear to clamp the telescope.

The locking sleeve is situated in the clamping head. It is a bronze cylinder having a feather way and is free to rotate independently of the clamping head. When the telescope is mounted and the clamping head rotated, the locking sleeve rotates and prevents the telescope moving back while it is being clamped.

The brow-pad bracket is cranked specially for use with the square box graticule telescope.

USE.

(i) To mount the telescope.

1. Slacken the brow pad bracket clamp.
2. Rotate the brow-pad to the left.
3. Unscrew the clamping head until the clamping sleeve is loose in the holder.
4. Align the feather way in the clamping sleeve with the feather way in the telescope holder.
5. Insert the telescope and push completely forward.
6. Tighten the clamping head.
7. Fit the illuminating attachment by pressing the plunger and sliding the attachment along the key-way on the graticule box.
8. Adjust the brow-pad.



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**MAINTENANCE**

(i) Checking and inspection.

1. Ensure that the three bolts which secure the carrier are tight.
2. Examine the locking sleeve for free movement and the clamping head for correct action.
3. Test the action of the clamp release pawl and spring.
4. Examine the telescope supporting surfaces for burrs.

(ii) Cleaning and lubrication.

1. Ensure that the telescope carrier and sleeve are clean.
2. Grease the nipple on the mantlet (Grease No. 1).

SECTION 6

Line instruments.  
Sighting telescopes.  
Marked handwheel.  
Clinometers.  
AFV Sight Gear.  
Angle of sight in  
Vision cupola.

NAME	POWER
Blade Vane Sight No. 1.	-
Vane, sighting Twin Blade No. 2.	-
Traverse Indicator	-
Telescope Sighting No. 43x3 ML Mk. 1 (first 23 tanks) or	3
Telescope Sighting No. 43 x3 ML Mk. 3 (after first 23 tanks)	3 or (alternative eye-piece)
Sight Clinometer Mk. 4.	
Clinometer Field, Mk. 6	



47.

SECTION 6 - SIGHTING AND FIRE CONTROL  
EQUIPMENT.

1. INTRODUCTION

Sighting and fire control equipment on the Challenger tank may be classified as follows:-

Line instruments.  
Sighting telescopes.  
Marked handwheel.  
Clinometers.  
AFV Sight Gear.  
Angle of sight instrument.  
Vision cupola.

TYPE	NAME	POWER	FIELD OF VIEW.	AMMUNITION	REMARKS
Line instruments	Blade Vane Sight No. 1.	-	-	-	Mounted on top of the turret in front of the crew commander's cupola.
	Vane, sighting Twin Blade No. 2.	-	-	-	Will be mounted on the turret floor.
	Traverse Indicator	-	-	-	
Sighting telescopes	Telescope Sighting No. 43x3 ML Mk. 1 (first 23 tanks) or	3	13°	17pr HE, APC and M.G.	Three range scales. False ranges required for HE (reduced charge) and APCBC
	Telescope Sighting No. 43 x3 ML Mk. 3 (after first 23 tanks)	3 or 6 (alternative eye-pieces).	13° or 9°	17pr APCBC, APC or HE 2950 ft/sec. (same scale) HE 1800 ft/sec. and M.G.	4 range scales The 6 power eye piece has an adjustable focus.
Marked handwheel	-	-	-	-	Elevating hand-wheel marked in 16 main divisions each equal to 4 minutes (approx) and sub-divided into 32.
Clinometers	Sight Clinometer Mk. 4.	-	-	-	Marked in degrees and minutes and fitted to a bracket on the left side of the gun mounting or on AFV Sight Gear.
	Clinometer Field, Mk. 6	-	-	-	Issued on the scale of 1 per squadron.



TYPE	NAME	POWER	FIELD OF VIEW	AMMUNITION	REMARKS.
AFV Sight Gear	AFV Sight Gear No.2	-	-	17pr HE 2950 ft/sec and HE(reduced charge) 1800 ft/sec.	Provided with a clinometer and range drum. Fitted to the left gun trunnion.
Angle of sight instrument	-	-	-	-	Used to take the angle of sight.

2. LINE INSTRUMENTS.

(a) BLADE VANE SIGHT NO. 1.

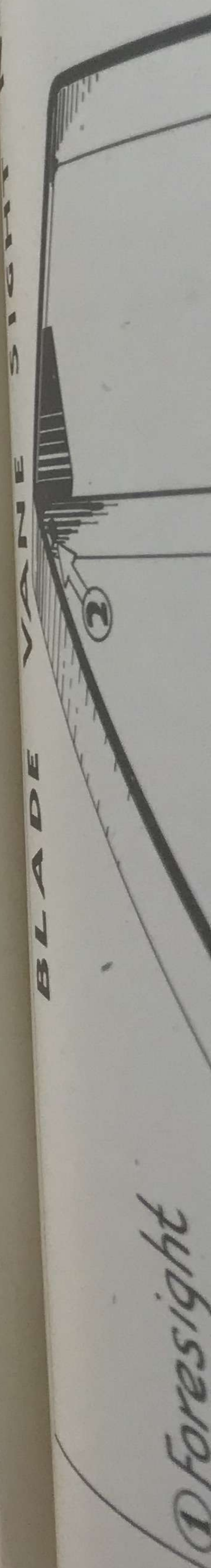
DESCRIPTION.

The blade vane sight is mounted on the outside of the turret forward of the commander's cupola. The sight consists of a twin blade backsight mounted in a triangular frame, and a single blade foresight mounted in a pentagonal frame. The foresight and backsight are bolted to a mounting base which, in turn, is secured to the turret. The foresight blade is secured at its lower end to a tensioning bolt mounted in the frame. The foresight frame is pivoted to enable the sight to be folded back. It is retained in its raised position by a spring. One spare backsight complete and 2 spare foresight blades are carried. See Figure 4.

USE.

The sight enables the crew commander to direct the gunner on to the target for line as follows:-

1. Order the gunner to traverse in the direction required.
2. Look through the backsight and order "Steady" when the target appears in the foresight frame.
3. Order "On" when the foresight is on the target and in the centre of the backsight.





## BLADE VANE SIGHT N° 1

- ① Foresight
- ② Foresight anchor pin
- ③ Foresight tension bolt
- ④ Twin blade backsight
- ⑤ Mounting base
- ⑥ Lateral adjust. slot
- ⑦ Retaining spring

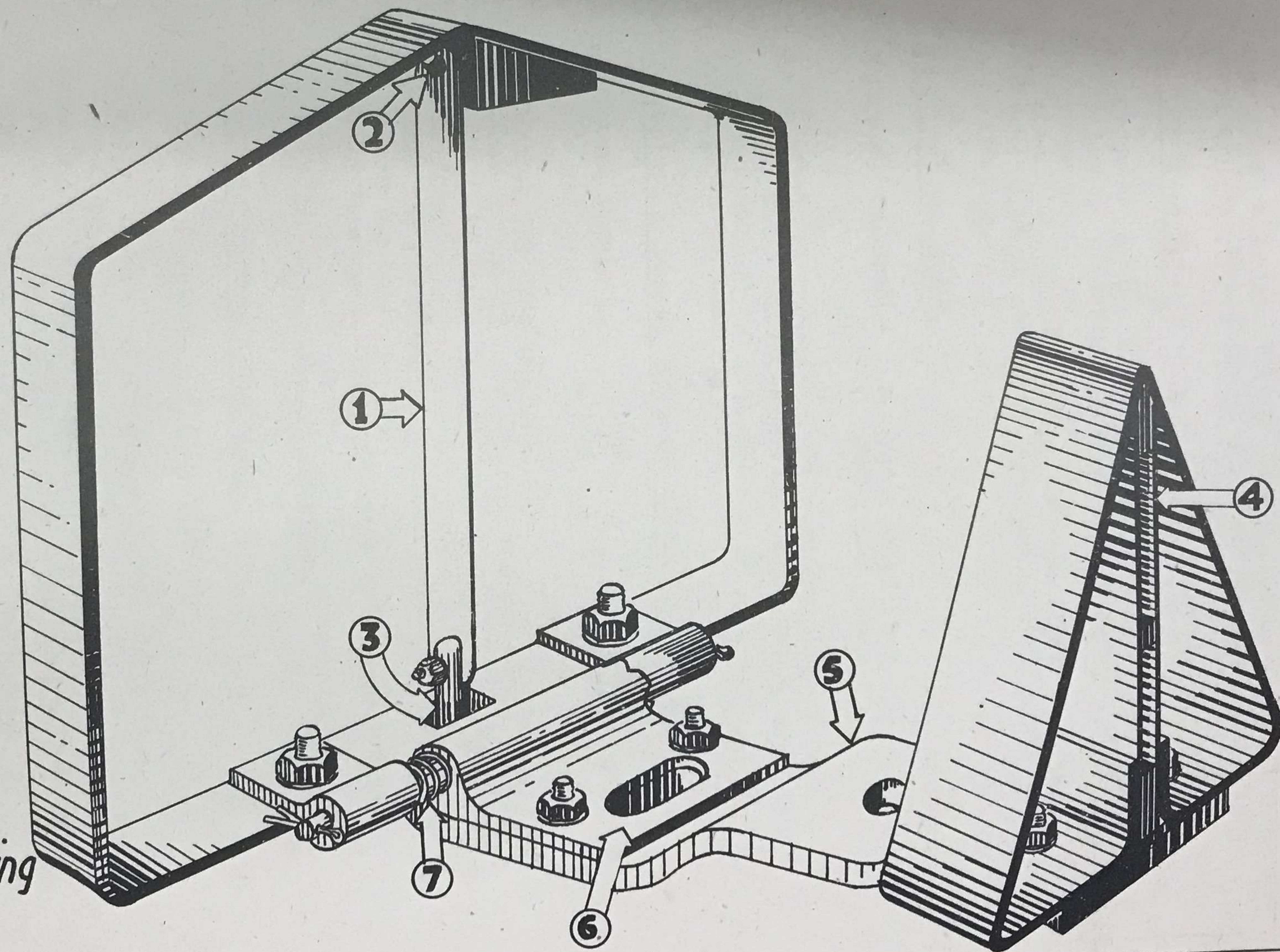


FIG. 4.



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# TESTS AND ADJUSTMENTS.

When sights have been tested and adjusted as described in paragraph 4, the commander will test the blade vane sight.

## To test the sight.

1. Order the gunner to lay the intersection of the telescope crosswires on a point approximately 2,500 yards away.
2. Check the gunner's aim and the vane sight. If the vane sight is not on the same point, it requires adjusting.

## To adjust the sight.

Equipment required:- 2 1/4" x 3/16" spanners.  
1 1/8" x 3/16" spanner.

1. Slacken the two nuts on the mounting base and move the sight until the foresight and target are aligned with the centre of the backsight.
2. Tighten the securing nuts.

## To replace a damaged foresight blade.

Equipment required:- 2 1/8" x 3/16" spanners.  
2 1/4" x 3/16" spanners.

1. Slacken the tensioning bolt.
2. Remove the small bolt securing the foresight blade.
3. Remove the blade from the anchor pin in the top of the frame.
4. Place the new blade in position and secure it to the tensioning bolt.
5. Apply tension to the blade until it is straight and rigid.
6. Check the adjustment of the sight.

## To replace a damaged backsight.

Equipment required:- 1/4" x 3/16" spanner.

1. Remove the two securing screws from the bottom of the frame.
2. Lift the backsight frame from the studs.
3. Place the new frame in position and secure with the two nuts.
4. Check the adjustment of the sight.

## MAINTENANCE

### Cleaning, lubrication and inspection.

The vane sight should be kept clean and inspected frequently for damage.

The foresight hinge should be lubricated and the spring checked for correct tension.



49 a.

(b) VANE SIGHTING, TWIN BLADE NO. 2.

DESCRIPTION.

This sighting vane is fitted on tanks equipped with the vision cupola. It consists of a twin blade foresight and twin blade backsight mounted vertically in a stout metal frame. The foresight blades are bolted to the baseplate of the frame and are connected to a distance piece and tensioning bolt mounted in the top of the frame. The hole for the tensioning bolt is elongated to allow adjustment of the blades. The backsight blades are bolted to a small bracket which is secured to the frame base plate by two bolts. The bolt holes are slightly larger than the bolts to enable the blades to be adjusted laterally. The top of the backsight is secured to a distance piece and tensioning bolt mounted in the top of the frame. The hole for the tensioning bolt is elongated to allow adjustment of the blades. A white line painted on top of the frame enables the gun to be laid for line in poor light. One spare set of blades is carried in the tank.

USE.

The sight enables the crew commander to direct the gunner on to the target for line as follows :-

- (i) Order the gunner to traverse in the direction required.
- (ii) Look through the backsight and order "Steady" when the target appears in the foresight frame.
- (iii) Order "ON" when the target appears in the centre of the backsight and the backsight is centred between the blades of the foresight.

TESTS AND ADJUSTMENTS.

When sights have been tested and adjusted the commander will test the sighting vane.

(i) To test the sighting vane.

1. Order the gunner to lay the intersection of the telescope cross-wires on a point approximately 2500 yards away. The gun trunnions should be cross-level.
2. Check the gunner's aim and the vane sight. If the sight is not laid on the same point, or the blades of the sight are not vertical, the sight requires adjusting.

(ii) To adjust the sighting vane.

Equipment required :- Two 1/8" x 3/16" spanners.  
One 1/4" x 5/16" spanner.

1. To set the blades vertical.

Ensure that the gun trunnions are cross-level and get the foresight blades vertical by slackening the tensioning bolt and moving it right or left. When the blades are vertical, tighten the tensioning bolt. Slacken the backsight bracket holding bolts and the rear of the two nuts which secure the sight to its bracket on the turret. Slacken the backsight tensioning bolt. Move the backsight in the frame until it is vertical. Tighten all bolts. The blades should be rigid and straight.



49. b.

2. To adjust the sight for line.

Lay the intersection of the telescope cross-wires on a point 2500 yards away. Slacken the two base plate securing nuts and pivot the sight bodily until it is laid accurately on the mark. Check the lay of the gun before tightening the securing nuts.

3. To replace a damaged blade.

Slacken the tensioning bolt, remove the upper and lower blade securing bolts and replace the defective blade. Check the adjustment of the sight before finally tightening the tensioning bolt.

MAINTENANCE.

The vane sight should be frequently inspected for damage and kept clean.



(c) TRAVERSE INDICATOR.

DESCRIPTION.

Details of this instrument are not yet available.

3. SIGHTING TELESCOPES.

(a) TYPES.

No.43 x3 ML Mk.3 (standard for all vehicles after first 23).  
No.43 x3 ML Mk.1 (first 23 vehicles)

As indicated by the letter "M", both telescopes have moving gratitudes. The telescope can be moved both in elevation and deflection by two adjusting knobs outside on the body of the telescope. The letter "L" indicates that the telescope body is provided with a means of illuminating the graticule.

(b) No. 43 x3 ML MK.3.

DESCRIPTION.

This telescope consists of a tube containing lenses, a circular graticule box with elevation and deflection knobs, a detachable eye-piece and an object glass protector. The telescope has four range scales, one for APC and HE 2950 ft/sec, one for APCBC, one for M.G. and one HE 1800 ft/sec. A deflection scale marked in 6-minute intervals is also provided. See Figure 4.

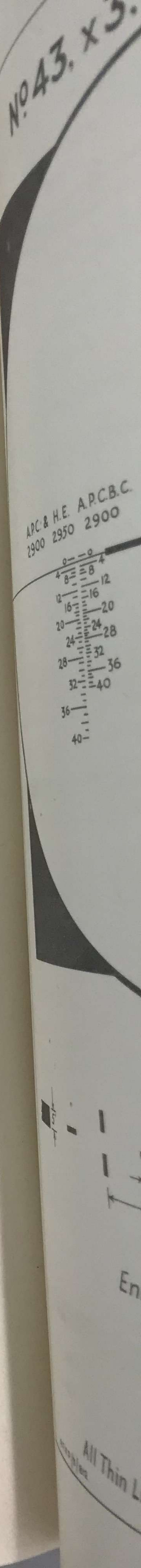
The eyepiece, of which there are two types provided - one of 3 magnification and the other 6 magnification, is secured to the graticule box by two spring loaded catches. This method of fitting enables the magnification of the telescope to be increased when necessary. The 3-power eyepiece is normally used. The 6-power eyepiece has an adjustable focus which is pre-set to an average adjustment. The gunner should NOT adjust the focus unnecessarily. The eye-piece is locked at the required focus by a set-screw. Both eyepieces are provided with rubber eye guards.

To illuminate the graticule, a red glass window is provided in the graticule box. An attachment, illuminating No.1, Mk.2 (12 or 24 volts) with a small electric bulb is fitted into a key way over the window. The attachment is connected to a battery. The light, when switched on, falls on to the graticule and is controlled by a rheostat (24 volt system) or by a light control (12 volt system). The light control is turned on by pressing a screw head. A scale is marked from 0 (no illumination) to 90 (full illumination) on the light control.

USE

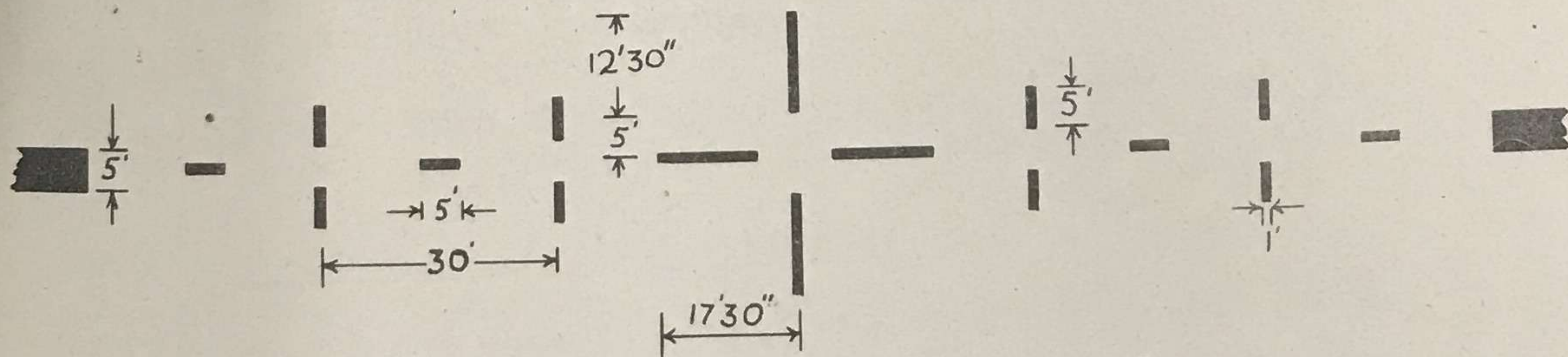
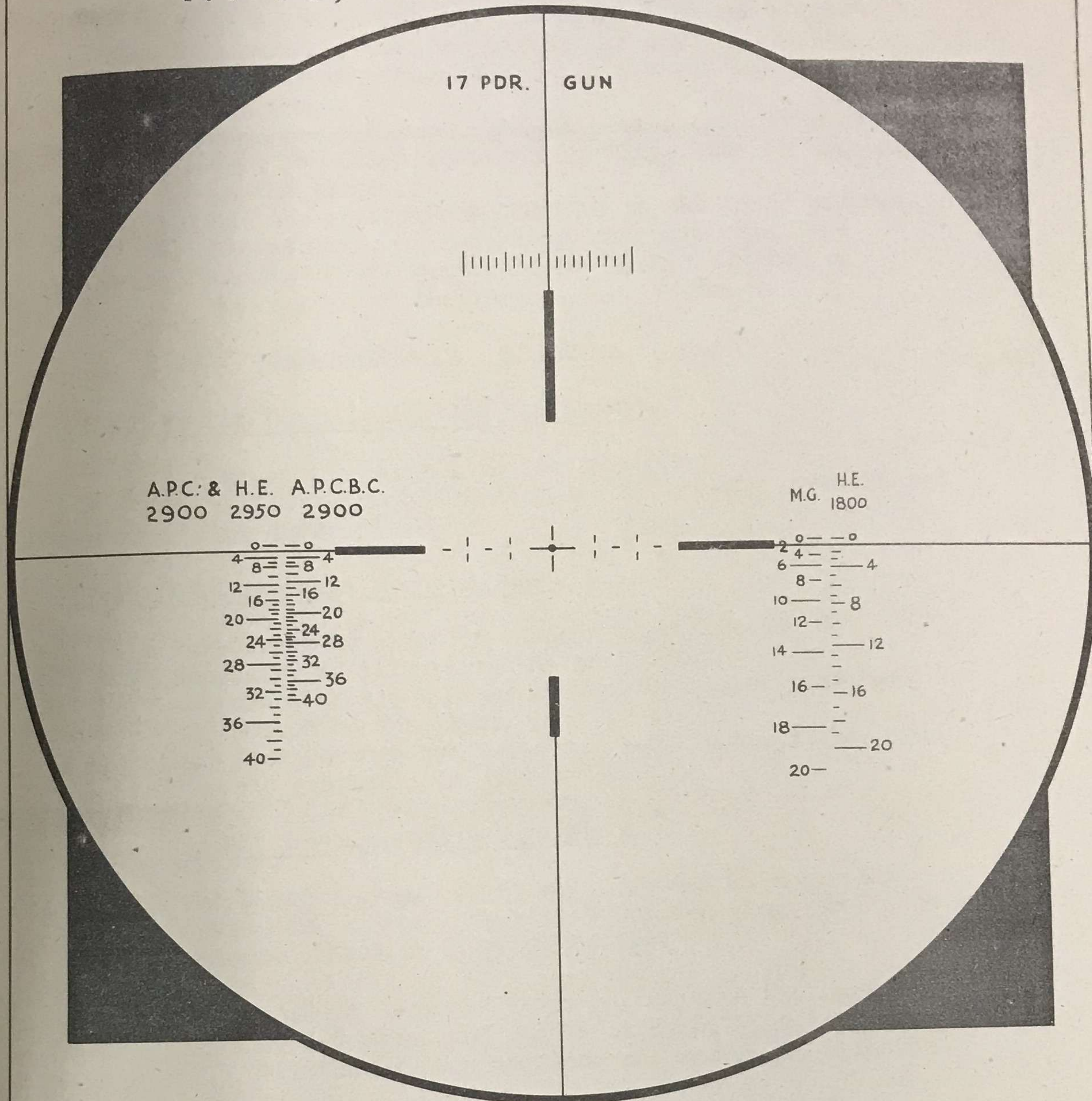
(i) To set the graticule

1. Ensure that the vertical wire is set at zero, i.e. in the centre of the deflection scale.
2. Rotate the elevation knob to bring the horizontal wire to the desired range in the correct scale. The wire must be set **ACCURATELY** to the required range which may be marked in the telescope or otherwise estimated by halving or quartering the interval.





# TELESCOPES No 43, x 3, M.L., MK.3 and 3/1.



Enlargement of Centre "AIM-OFF" Lines

Deflection Scale marked at 6' Intervals

All Thin Lines 1' THICK

All Thick Lines 5' THICK



51.

(ii) To lay the telescope.

1. Ensure that the seat is adjusted to the correct height and that the browpad is comfortable and allows the maximum field of view through the telescope.
2. Traverse the gun in the direction ordered by the crew commander until the vertical wire is aligned on the target.
3. Set the graticule **ACCURATELY** to the range ordered.
4. Elevate and, if necessary, traverse until the centre of the graticule is **EXACTLY** aligned on the centre of the target. See Figure 5.

PRECISION IS ESSENTIAL

(iii) To fit the illuminating attachment.

1. Press the plunger on the attachment.
2. Slide the attachment on to the key-way over the red window.

(iv) To illuminate the graticule.

For firing at night or in poor light, it may be necessary to illuminate the graticule. It is essential that the light is kept as dim as possible.

1. Switch on the light.
2. Look through the telescope and dim the light until the graticule is just visible.

(v) To fit the alternative eye-piece.

The 6-power eyepiece, which is stowed in a special container, is normally fitted for engaging targets at extreme ranges in good visibility.

1. Hold the 3-power eyepiece, release the spring loaded clips and remove it by pulling to the rear.
2. Fit the 6-power eyepiece and secure it with the clips.
3. Stow the other eye-piece in the container.
4. Re-adjust the browpad.

Note:- When changing the eyepiece, do NOT touch the graticule window in the telescope.

(vi) To focus the 6-power eyepiece.

1. Choose a well-defined object at about 4000 yards.
2. Set the graticule to 4000 yards.
3. Slacken the set-screw and adjust the focus by turning the eyepiece until both the object and the graticule are well-defined.
4. Tighten the set-screw.



52.

(vii) To exchange the object glass protector.

During action, the object glass protector may become damaged or coated with bullet splash. It is renewed (from spares) as follows:-

1. Remove the telescope from its mounting.
2. Remove the protector from the front of the telescope body by pressing in the two milled catches and withdrawing the protector.
3. Insert the new protector, press in the catches and ensure that the protector is correctly engaged with the telescope body.
4. Replace the telescope in the mounting.
5. At the first opportunity, check sight adjustment.

ADJUSTMENTS

The telescope is adjusted for deflection and elevation during sight testing as follows:-

1. Loosen the locking rings on the telescope mounting and slacken the four adjusting screws slightly.
2. Ensure that the vertical wire is in the centre of the deflection scale and that the horizontal wire is at zero.
3. To move the cross wire to the left, tighten the left hand adjusting screw and slacken the opposite screw by the same amount.  
To move the crosswire to the right, tighten the right screw and slacken the opposite screw.
4. To move the crosswire UP, tighten the upper adjusting screw and slacken the opposite screw by the same amount.  
To move the crosswire DOWN, tighten the lower screw and slacken the upper.
5. Tighten ALL adjusting screws equally and the locking rings.
6. Check that the setting of the telescope has not been disturbed.

MAINTENANCE

Care and cleaning.

General.

Telescopes should be treated with the greatest care and must NOT be taken to pieces except by qualified REME personnel. Oil and grease must NOT be allowed on any of the lenses or on the telescope eye-guard.

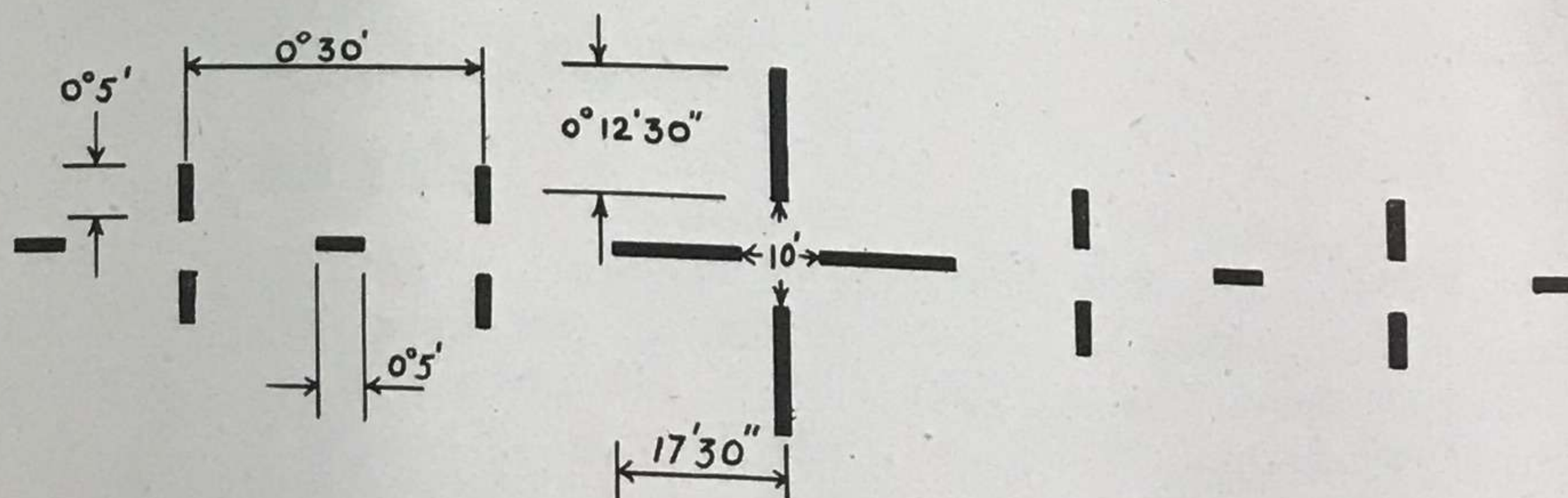
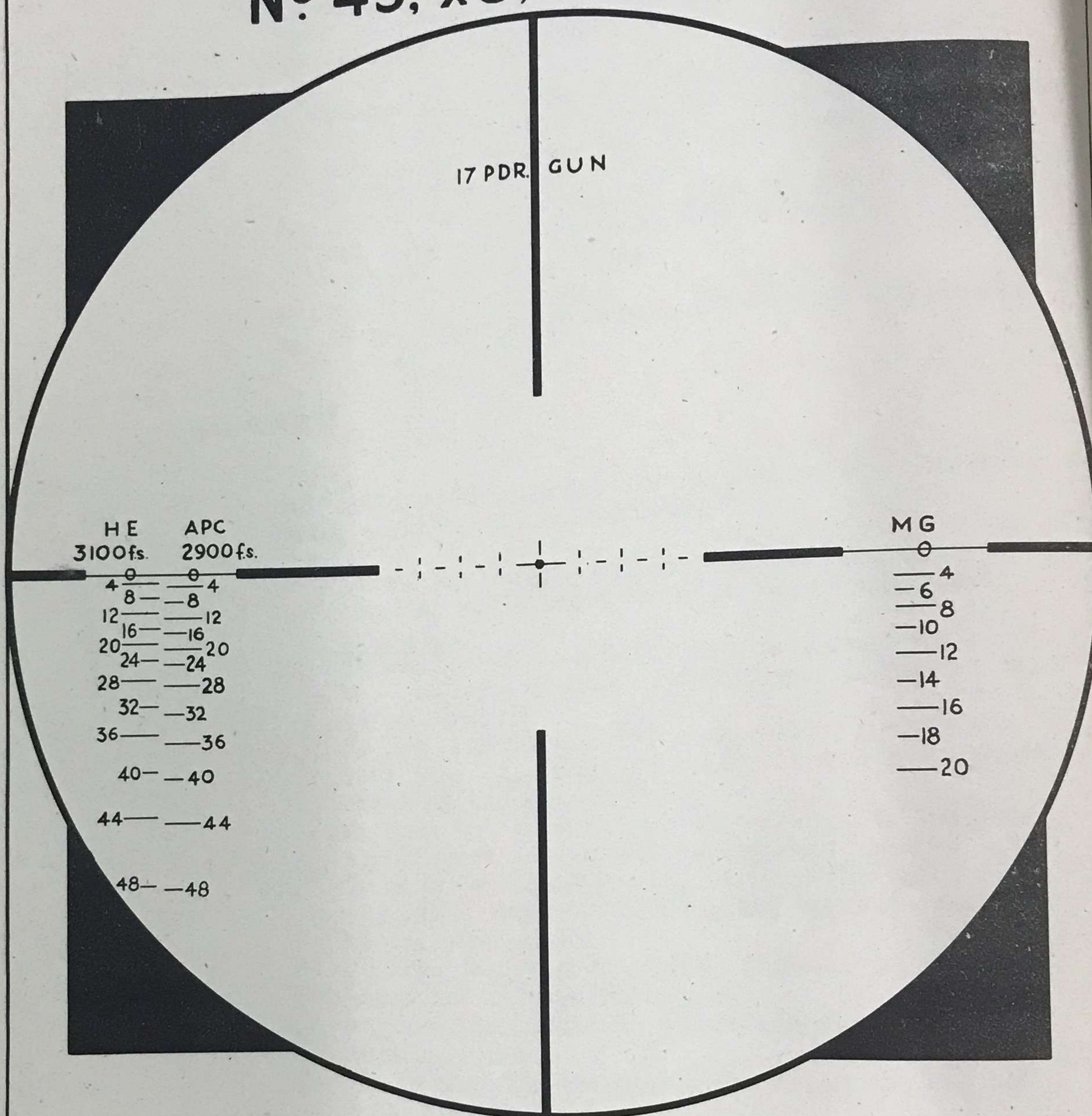
Cleaning materials.

The following cleaning materials are being issued as standard tank equipment:-

- A camel hair brush.
- Tissue paper.
- A polishing cloth known as Selvyt.



# TELESCOPE No 43, x3, M.L., MK. I.



Enlargement of Centre "AIM-OFF" Lines

All Thin Lines 1' THICK

All Thick Lines 5' THICK

AFVP/D/BIO.

FIG. 6.

These materials should be stored in the space provided.

Method of cleaning

1. Remove, with t
2. Wipe any mud, lenses or in
3. Finally, poli

Eye-guards.

To remove oil or rag soaked in pe remove the petr water to which If the eye-guar it can be made

Misting.

Telescopes sho moisture. and eyepiece compound No.

DEFECTS

Telescopes should bearing surfaces Damaged lenses, be reported and

To test for par

1. Set the cr
2. Lay the gra
3. Move the
4. If the gra for paral sent for

(b) No. 43 x3 M.L.

DESCRIPTION.

This telesco oblong grat an elevation (on the top adjustable elevation blue enamel to improve with a rul Gunner's The teles ft/sec an The mean for the



53.

These materials must be kept free from oil and grit and stowed in the special dust-proof container which is being provided.

Method of cleaning.

1. Remove, with the brush, any dry dust or specks on the lenses or in crannies.
2. Wipe any mud, oil or grease with the tissue paper and discard the paper.
3. Finally, polish the lenses with Selvyt.

Eye-guards.

To remove oil or grease, wipe the eye-guard with a clean rag soaked in petrol. Then thoroughly dry the rubber to remove the petrol. Eye-guards may also be washed in water to which a little soap or soda has been added. If the eye-guard becomes distorted or loses its pliability it can be made supple by steeping it in hot water.

Misting.

Telescopes should be protected as far as possible from moisture. To prevent misting, the object glass protector and eyepiece lens should be lightly coated with anti-dim compound No. 2.

DEFECTS

Telescopes should be examined frequently for burrs on the bearing surfaces which will cause the body to be distorted. Damaged lenses, dented tubes and presence of parallax should be reported and the telescope repaired or exchanged.

To test for parallax.

1. Set the crosswire to ZERO.
2. Lay the graticule on an aiming-mark at 1200 yards.
3. Move the head while looking at the aiming mark.
4. If the graticule appears to move with the head, adjustment for parallax is incorrect, and the telescope should be sent for repair.

(b) No. 43 x3 ML Mk. 1.

DESCRIPTION.

This telescope consists of a tube containing lenses, an oblong graticule box with a deflection drum (left side) an elevation drum (underneath) and a range scale adjuster (on the top of the box) enclosed by a screwed cap. An adjustable skin is incorporated in both deflection and elevation drums. The graticule box is marked "E" in blue enamel to indicate that the lenses have been bloomed to improve light transmission. The eye-piece is fitted with a rubber eye-guard No. 3 to exclude light from the gunner's eye.

The telescope has three range scales, 17-pr APC, HE 2950 ft/sec and M.G. See Figure 6.

The means of illumination is similar to that described above for the No. 43 x3 ML Mk. 3.



54.

USE.

(i) To set the graticule.

1. Ensure that the deflection drum is set at zero (i.e. when the white line on the skin is adjacent with the indicator).
2. Rotate the elevation drum to bring the horizontal wire to the desired range in the correct scale.

The wire must be set ACCURATELY to the required range which may be marked in the telescope or otherwise estimated by halving or quartering the interval.

(ii) To lay the telescope.

As for No. 43x3 ML Mk. 3.

(iii) To fit the illuminating attachment.

As for No. 43 x3 ML Mk. 3.

(iv) To illuminate the graticule

As for No. 43 x3 ML Mk. 3.

(v) To exchange the object glass protector.

As for No. 43 x3 ML Mk. 3.

ADJUSTMENTS

The telescope is adjusted for deflection and elevation during sight testing as follows:-

1. Set the graticule to ZERO.
2. Turn the deflection drum until the vertical wire has moved in the direction and by the amount required.
3. If the white line on the skin of the drum does NOT coincide with the indicator on the graticule box, adjust as follows:-

Loosen with a coin or large screwdriver the locking screws in the drum by NOT more than one turn. Hold the drum still and slip the skin until the white line and indicator coincide. Tighten the locking screw and check that the vertical wire has not moved during adjustment.

4. Turn the elevation drum until the horizontal wire has moved in the direction and by the amount required.
5. If the white line on the skin of the drum does NOT coincide with the indicator, adjust the skin as described in 3 above.
6. Adjust the range scale as follows:-

Unscrew and remove the small cap on top of the graticule box. Rotate the adjusting screw so as to bring the required mark of the range scale on to the horizontal cross wire. Replace the cap.

Telescope  
Spare, tel  
Pieces of  
Grease.  
Binocular  
Two 1/4"  
Small ad

to align the axis of the  
sighting mark.

It is convenient to  
Choose an aiming mark  
clearly defined as  
if possible). The  
of the sun. It  
as to enable a point  
A flag-pole, telegraph  
lorry with superstructure  
testing sights in  
sighting charts and  
Place pieces of tape  
brake precisely to  
vertical scribe  
if grease is in use  
first thread is  
second is being

Note: When a gun  
marks on  
gunfitter  
bore.

(iv) Examine the telescope  
clean, and inspect  
All nuts and bolts  
must be secured  
(v) Test the telescope  
(vi) Remove the at

SIGHT



55.

## MAINTENANCE

Care and cleaning.

As for No. 43x3 ML Mk. 3.

## DEFECTS.

As for No. 43x3 ML Mk. 3.

4. TESTING AND ADJUSTING SIGHTS.

## Equipment required:-

Telescope No. 43 x3 ML Mk. 1 or 3.  
 Spare telescope (if provided).  
 Pieces of fine black thread.  
 Grease.  
 Binoculars.  
 Two 1/4" x 5/16" spanners.  
 Small adjustable spanner.

## (a) THE GUN

Object.

To align the axis of the bore and the telescope on the same aiming mark.

PREPARATION.

- (i) It is convenient to have the tank on level ground.
- (ii) Choose an aiming mark approximately 1200 yards away that is clearly defined against a contrasting background (the sky if possible). The mark should not be in the direction of the sun. Its shape and proportions should be such as to enable a point of aim to be determined accurately. A flag-pole, telegraph-pole, corner of a building or 3-ton lorry with superstructure and tarpaulin are suitable. For testing sights in harbour and in close country, special sighting charts are being prepared.
- (iii) Place pieces of thread across the end of the gun muzzle brake precisely through the line of the horizontal and vertical scribe marks, and secure the thread with grease or, if grease is ineffective, insulating tape. Ensure that the first thread is not moved off the scribe marks when the second is being placed in position.

Note: When a gun is delivered to a unit, the scribe marks on the muzzle brake should be inspected by a gunfitter to ensure that they cut the axis of the bore.

- (iv) Examine the telescope and mounting to see that they are clean, and insert the telescope. Adjust the browpad. All nuts and other components on the telescope mounting must be secure.
- (v) Test the telescope for parallax.
- (vi) Remove the striker case from the 17-pr gun.

SIGHTS MUST BE TESTED AND ADJUSTED BY THE SAME MAN.



56.

TESTING.

- (i) Align the gun roughly on the aiming mark.
- (ii) Place the left tube of the binoculars centrally against the striker recess in the breech block.
- (iii) Focus the eyepiece until the cross threads and aiming-mark are as clear as possible.
- (iv) Lay the gun accurately on the corner of the target first for line and then for elevation.
- (v) Remember in which direction the gun was finally moved both for line and elevation so that the telescope graticule can be moved in the same way for consistency, i.e. if the gun is laid for line by traversing from left to right and for elevation by depressing the gun on to the mark, the graticule should be laid in the same way.
- (vi) Look through the telescope, ensure that the crosswire is set to zero and check the point of aim. If the sight is correct, the centre of the graticule will be laid exactly on the same point as the axis of the bore.

ADJUSTING.

- (i) If the sight is not correctly aligned, adjust as described in paragraph 3 (a) or (b) above.
- (ii) Replace the striker case after adjustment.

(b) THE COAXIAL MACHINE GUN.

TESTING.

- (i) Remove the rear plate and breech block from the machine gun.
- (ii) Look through the bore and check the alignment. If the aiming mark does not appear in line with the axis of the bore, adjust as follows:-

ADJUSTING.

- (i) Unscrew the transverse stop screws.
- (ii) Slacken the clamping bolt at the rear of the cradle and the locking nut securing the elevating joint.
- (iii) Screw the elevation adjusting head up or down until the machine gun is correct for elevation.
- (iv) Move the rear of the gun until it is correct for line.
- (v) Tighten the transverse stop screws until they just touch the machine gun body and tighten the locking nuts.
- (vi) Check that the bore is still laid on the aiming mark.
- (vii) If the bore cannot be laid on the mark, the mounting must be aligned by an armourer.

(c) THE BLADE VANE SIGHT AND TWIN BLADE SIGHTING VANE.

Adjust the sight as described in paragraph 2 above.

5. SHOOTING-IN

(a) OBJECT.

To adjust sights so that the strike of shot at a given range coincides with the point of aim.

... destroys the relation  
... the telescope when sight  
... visual adjustment  
... has been made for  
... errors are eliminated

... of the range at which  
... of factors, of which  
... range chosen must give  
... within its effective range  
... enable the gunner to  
... be marked by a graticule  
... telescope is mounted  
... left of the gun. The  
... right will tend, at long  
... by the distance between  
... the accuracy obtained by  
... at long range too.

... therefore, been decided  
... 1200 yards will be  
... mounting.

... For training.

... A black screen 6ft square  
... be used as a target.  
... be divided into 1ft square  
... firing point) should be  
... squares marked for co-  
... lettered A,B,C,D,E,F and  
... 1,2,3,4,5).

... In the field

... In the field, when it  
... of target, it is possible  
... target as long as it is  
... a direct vehicle pro  
... visible bush or stone  
... that the strike of sh  
... be easily observed in  
... a long way behind the  
... at a measured range o

... Set up the target at  
... ensure that the verti  
... central in the deflec  
... of the deflection dra  
... horizontal crosswire  
... take a central point  
... first round of point  
... delay immediately



## (b) ITS IMPORTANCE.

Shooting-in destroys the relationship established between the gun and the telescope when sights are tested and adjusted visually. Visual adjustment does not ensure that the strike of the shot will coincide with the point of aim for several reasons - no allowance has been made for wear in the bore, jump, drift or droop. The above errors are eliminated at a given range by shooting-in.

## (c) RANGE

The choice of the range at which the 17-pr gun is shot-in depends on a number of factors, of which the chief are:-

- (i) The range chosen must give the gun the greatest accuracy within its effective AP range.
- (ii) To enable the gunner to take an accurate aim this range must be marked by a graticule in the telescope.
- (iii) The telescope is mounted approximately 13 inches to the left of the gun. The drift of the projectile to the right will tend, at long range, to reduce the error caused by the distance between the gun and the telescope, so that the accuracy obtained by shooting-in at medium range exists at long range too.

It has, therefore, been decided that, of the ranges marked in the telescopes, 1200 yards will best meet the requirements for this gun and mounting.

## (d) THE TARGET.

(1) For training.

A black screen 6ft square with a white bull 2ft square will be used as a target. The screen (except the bull) should be divided into 1ft squares. The crew commander (at the firing point) should have a replica of the target with the squares marked for co-ordination (i.e. the squares are lettered A,B,C,D,E,F horizontally and then numbered vertically 1,2,3,4,5).

(ii) In the field

In the field, when it is impracticable to use the above type of target, it is possible to shoot-in against any form of target as long as it affords good observation of near misses. A derelict vehicle provides an excellent target, but a clearly visible bush or stone will do if it is on rising ground so that the strike of shots which are plus, left or right can be easily observed instead of their point of impact being a long way behind the target. The target MUST be sited at a measured range of 1200 yards.

## (e) METHOD

- (i) Set up the target at the correct range (measured).
- (ii) Ensure that the vertical crosswire in the telescope is central in the deflection scale. Slacken the screw of the deflection drum (Mk.1 telescope) and set the horizontal crosswire at 1200 yards.
- (iii) Take a central point of aim and fire one round. The first round of the day should be ignored. Relay immediately on the same point.



58.

- (iv) The strike of shot will be shewn by a marking disc displayed at the butts or observed with binoculars from the firing point. The crew commander or instructor will, if necessary, point out the position of the strike to the gunner.
- (v) The gunner, without disturbing the gun, will adjust the sight on to the strike, correcting first for line and then for elevation. He will adjust the No. 43 x 3 ML Mk. 1 telescope by means of the adjusting knobs on the bracket.
- (vi) He will then relay on the centre of the target, fire again and continue to move the sight until a shot hits the bull. Another round will be fired for confirmation. If using the No. 43 x 3 ML Mk. 1 telescope adjust the range scale to exactly 1200 yards by means of the range scale adjuster.

GUNS SHOULD NOT BE SHOT-IN IN A HIGH WIND.

Note :- The gunner should be trained in shooting-in on the pellet range and 30 yards range before firing in the open. See "Range Practices", MTP No. 34, Part 6, 1945.

## 6. PROCEDURE FOR RECORDING SHOOTING-IN ADJUSTMENTS.

### (a) EXPLANATION.

If the relationship between the visual test and adjustment and shooting-in is known, shooting-in will not be necessary as long as the gun retains its accuracy. The accuracy should be checked by shooting-in after each quarter of the gun's life.

Note :- To determine and record this relationship, the field clinometer and the traverse indicator are used. On early models of the Challenger tank, no traverse indicator is fitted and adjustments made during shooting-in cannot be recorded.

### (b) METHOD.

- (i) Test and adjust the sight visually and shoot-in.
- (ii) Set the sight to ZERO.
- (iii) Place cross threads on the muzzle of the gun.
- (iv) Look through the bore and lay the crossthreads on the corner of the target used in the visual test and adjustment.
- (v) Set the traverse indicator to ZERO.
- (vi) Lay the field clinometer on the breech and take the reading (e.g. 1 degree 10 minutes).
- (vii) Lay the telescope graticule on the same aiming mark by means of the elevating and traversing wheels.
- (viii) Note the reading on the traverse indicator (e.g. 3 minutes).
- (ix) Adjust the field clinometer until the bubble is central and note the reading (e.g. 1 degree 13 minutes).
- (x) Record the displacement of the bore made during shooting-in.

#### 1. Lateral displacement.

If the traverse indicator reading with the bore laid on the aiming mark was ZERO and with the telescope laid on the same point the reading was 3 minutes, the bore has been displaced from the visual test and adjustment position through an angle of 3 minutes.

#### 2. Vertical displacement.

If the clinometer reading with the bore laid on the aiming mark was 1 degree 10 minutes, and with the telescope laid on the same point the reading was 1 degree 13 minutes, during shooting-in the bore has been displaced from the visual test and adjustment position through an angle of +3 minutes (Up 3 minutes).



The adjustments together with the reverse adjustments (from shooting-in to T and A) should be recorded in a prominent place in the turret for subsequent sight testing, as follows :-

Gun No.	Telescope No.	Adjustment for this sight.	
		From T and A to shooting-in.	From shooting-in to T and A.
	No. 45 x3 ML Mk. 3 126.	Left 3 minutes Up 3 minutes	Right 3 minutes Down 3 minutes.

(c) SUBSEQUENT SIGHT TESTING.

Sights should be tested weekly, before firing and whenever a telescope is replaced :-

- (i) Prepare the tank as in 4(b).
- (ii) Lay the bore of the gun on an aiming mark at 1200 yards.
- (iii) Set the traverse indicator to zero and the field clinometer bubble central.
- (iv) Using the traverse indicator and field clinometer, traverse and elevate the gun according to the adjustments recorded after shooting-in (e.g. Left 3 minutes, up 3 minutes).
- (v) Check the lay of the telescope and, if necessary, adjust the intersection on to the aiming mark.

Note :- In order to avoid errors due to backlash, when laying the bore on the aiming mark, the final movements of the elevating and traversing wheels must be in the direction of the recorded adjustments, e.g. if the recorded adjustments are "Left 3 minutes, up 3 minutes" the final movement of the handwheels must be left and up respectively.

7. MARKED ELEVATING HANDWHEEL.

(a) DESCRIPTION.

The elevating handwheel is engraved with 16 equally spaced lines numbered from 1 to 16 and sub-divided to give a total of 32 divisions. Each 16th = 4 minutes (approximately).

(b) USE.

The handwheel markings are used in two ways :-

For targets visible to the gunner but at ranges beyond those marked in the range scale.

- (i) Set the telescope graticule to zero.
- (ii) Lay the zero mark in the telescope on to the target (to allow for the angle of sight).
- (iii) Elevate the gun by the number of turns and divisions required for the range.

For targets not visible to the gunner

- (i) Level the gun by means of the clinometer.
- (ii) Elevate the gun by the number of turns and divisions required for the range.

Note :- The AFV sight gear, if fitted, will be used in preference to handwheel markings.



# 8. SIGHT CLINOMETER MK. 4.

## (a) DESCRIPTION

The sight clinometer Mk. 4 is clipped to a bracket on the AFV Sight Gear. If the AFV sight gear is not fitted, the clinometer is clipped to a bracket on the left side of the gun mounting. The spirit level is contained in an arc moved by worm gearing. Three scales are fitted; the coarse scale on the right of the instrument is marked in degrees from zero to 20 degrees, in one direction for elevation and in the other for depression. Two micrometer scales, one for elevation and the other for depression are marked at intervals of five minutes.

## (b) USE

The clinometer may be set to zero for levelling gun, to the angle of sight or to an angle of quadrant elevation. Unless otherwise ordered, the clinometer will be set to ZERO.

### TO SET AN ANGLE ON THE CLINOMETER

- (i) Press down the forward micrometer head and slide the arc forward (for an angle of depression) or to the rear (for an angle of elevation) until the pointer is opposite the required setting on the degree scale.
- (ii) Turn the micrometer until the degree scale is reading the number of degrees ordered and the micrometer scales are reading zero minutes.
- (iii) For angles of ELEVATION, turn the micrometer CLOCKWISE until the rear micrometer scale is reading the number of minutes ordered. For angles of DEPRESSION, turn the micrometer ANTI-CLOCKWISE until the forward micrometer scale is reading the number of minutes ordered.

### TO SET THE GUN AT A REQUIRED ANGLE.

- (i) Set the angle on the clinometer.
- (ii) Elevate the gun until the bubble is in the centre of its run.

## (c) TEST AND ADJUSTMENT.

Equipment required:- Spanner No. 244.

### ZEROING THE CLINOMETER (when fitted to gun mounting).

When the gun is level and the sight clinometer is set to ZERO, the bubble should be in the centre of its run.

#### (i) To test.

1. Check the tightness of the sight clinometer bracket.
2. Set the sight clinometer to zero and clip it to the bracket.
3. Level the gun with the field clinometer (which has been tested for index error).

If the bubble of the sight clinometer is central, then zeroing is correct.  
If it is not central, then bring it so by turning the micrometer head.  
Note the reading.

2. Move the  
3. Slacken the  
the scale to zero  
adjust the other  
4. Repeat the test.  
It is a large adjustment  
necessary to adjust  
set screws and move

1. Wipe the outside  
of cloth.  
2. Press down the  
arc to one side  
3. With a clean  
arc.  
4. Slide the arc  
the remainder

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of cloth.  
2. Press down the  
arc to one side  
3. With a clean  
arc.  
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4. Slide the arc  
the remainder



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(ii) To adjust.

1. Remove the clinometer.
2. Slacken the nut securing one micrometer scale, slip the scale to zero and re-clamp. Adjust the other micrometer.
3. Repeat the test.

Note:- If a large adjustment has been made, it will be necessary to adjust the degree scale, by slackening the set screws and moving the scale.

(d) MAINTENANCE.

The clinometer should be handled with care and protected from dust and grit. The presence of dust and grit on the teeth of the arc or on the worm will cause wear and lead to backlash.

(i) To clean the clinometer.

1. Wipe the outside of the instrument with a clean piece of cloth.
2. Press down the depression micrometer head and slide the arc to one side as far as it will go.
3. With a clean cloth, clean the exposed teeth of the arc.
4. Slide the arc fully in the opposite direction and clean the remainder of the teeth.

(ii) To lubricate the clinometer.

The teeth of the arc should be lightly smeared with Grease No. 0.

9. FIELD CLINOMETER MK. 6.

(a) DESCRIPTION.

The clinometer is in the form of a quadrant with a pivoting arm which carries the bubble in a slider. The quadrant has two coarse scales marked from -1 degree to +44 degrees and from +45 degrees to +89 degrees. The arm can be set at the required angle by engaging a plunger with the notches on the quadrant which are set at intervals of 1 degree. The arm is marked on each side with a scale of minutes from zero to 60 minutes. The slider can be locked in position by a milled screw.

(b) USE

The field clinometer is used as a master clinometer for levelling the gun when testing the sight clinometer or AFV Sight Gear.

TO SET THE CLINOMETER

- (i) Press in the plunger and move the arm until the pointer is opposite the required setting on the degree scale. Release the plunger.
- (ii) Slacken the milled screw and move the slider until it is opposite the required graduation on the minute scale. Tighten the screw.



TO LEVEL GUN.

- (i) Set the clinometer to zero.
- (ii) Ensure that the clinometer plane on the breech ring is clean.
- (iii) Set the clinometer on the breech ring and parallel to the axis of the bore.
- (iv) Elevate or depress the gun until the bubble is at the centre of its run.

(c) TEST AND ADJUSTMENT (INDEX ERROR)

- TEST AND ADJUSTMENT (INDEX ERROR).
- (i) Set the clinometer at zero and place it on the clinometer plane of the breech ring.
  - (ii) Centralise the bubble by elevating or depressing the gun.
  - (iii) Turn the clinometer end for end.
  - (iv) If the bubble remains in the centre of its run, the clinometer is correct. If it is not central, move the slider or arm of the clinometer until it is so and note the reading.

reading.  
Half this reading is the index error of the clinometer.

Adjustment for index error will be done only by a gunfitter. Until this is possible, allowance must be made for the index error whenever the clinometer is used. The ascertained index error will be set on the clinometer and all readings calculated from it. For example, if the index error is 2 minutes, the clinometer will read 2 minutes and NOT zero when levelling gun.

(a) MAINTENANCE

The clinometer should be handled with care and kept clean. It will be kept in its box when not in use.

10. AFV., SIGHT GEAR NO. 2,

(a) DESCRIPTION.

The sight gear is secured to the left trunnion of the 17 pr gun mounting by means of an adaptor plate and four bolts with locking washers. It consists of the following principal parts:-

- (i) The range adjuster is a star shaped handwheel and is the means by which the gear is operated. It is connected by a shaft to worm gearing which drives the range cam. The shaft is spring loaded to prevent backlash.
- (ii) The range cam is made of steel and, when rotated, moves the cam follower.
- (iii) The cam follower is secured to the clinometer bracket which is pivoted on the body of the sight gear. When the range cam is rotated, the follower moves the clinometer bracket through an angle determined by the degree of rotation and the contour of the cam. A stop screw is fitted to limit the movement of the clinometer bracket and prevent strain on the range cam.

The range drum is secured to the spindle and rotates with the scales for HE full scale reader is attached to the range drum.

... gear is used for engaging  
... targets outside the range  
... will set the clinometer  
(taken), adjust the range  
... the gun until the bubble  
... commander decides to take  
... of the sight clinometer from  
... the sight instrument, set the  
... the clinometer on the  
... the setting of the  
... drum to the required r  
... is level. Correction

ADJUSTMENT 3.

Initial setting of the sight

When the sight gear adaptor  
trunnion initially, the  
that the two upper holes  
as nearly as possible par  
four holes in the adapto  
adaptor plate is attache  
holes and a small amount  
If the fitter brings the  
parallel to the axis of  
prevent the need for

1. Level the gun with the bubble level.
  2. Fit the sight clinometer to its bracket.
  3. Turn the range adjustment screw until the bubble is at the center.
  4. Slacken the range drum clamp.
  5. Tighten the clamp.
6. The guns of a unit have comparative calibration (see page 10) and must be carried out, since the range drum is at zero.
7. To test the cam-follower:
1. Turn the range drum to the extreme left.
  2. Turn the range drum to the extreme right.



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- (iv) The clinometer bracket is spring loaded and shaped to carry the sight clinometer Mk. 4.
- (v) The range drum is secured by a clamping screw to the range cam spindle and rotates with the drum. It is provided with range scales for HE full and reduced charge ammunition. A scale reader is attached to the sight gear body.

(b) USE.

The sight gear is used for engaging targets not visible to the gunner or targets outside the range of the telescope. The gunner will set the clinometer to zero (if the angle of sight is not taken), adjust the range scale to the required range and elevate the gun until the bubble is level. If the commander decides to take the angle of sight, he will remove the sight clinometer from the sight gear, clip it to the angle of sight instrument, set the angle of sight on the clinometer and replace the clinometer on the sight gear. The gunner must NOT disturb the setting of the clinometer. The gunner then adjusts the range drum to the required range and elevates the gun until the bubble is level. Corrections will be given in yards on the range drum.

(c) TESTS AND ADJUSTMENTS.(i) Initial setting of the sight gear.

When the sight gear adaptor plate is bolted to the trunnion initially, the gunfitter should check that the two upper holes which carry the sight gear are as nearly as possible parallel to the axis of the bore. The four holes in the adaptor plate, by means of which the adaptor plate is attached to the trunnion, are clearance holes and a small amount of movement is thus obtainable. If the fitter brings the two horizontal bolt holes parallel to the axis of the bore in this way, he will prevent the need for undue adjustment on the sight gear.

(ii) To adjust the range drum.

1. Level the gun with the field clinometer.
2. Fit the sight clinometer to its bracket and set it at zero.
3. Turn the range adjuster until the sight clinometer bubble is at the centre of its run.
4. Slacken the range drum clamp and slip the drum to zero. Tighten the clamp.

If the guns of a unit have been calibrated by the system of comparative calibration (see paragraph 12 below) the above test will not be carried out, since the gun will not necessarily be level when the range drum is at zero.

(iii) To test the cam-follower spring.

1. Turn the range adjuster until the range drum is set at the extreme range.
2. Bring the range drum back to zero by means of the range adjuster and at the same time, note the action of the cam follower spring.



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3. If, at any time during the check, the cam follower loses contact with the cam, report to a gunfitter.

(d) MAINTENANCE

CHECKING AND INSPECTION.

- (i) Ensure that the bracket is securely fastened to the gun trunnion.
- (ii) Ensure that the range readers are undamaged.

CLEANING AND LUBRICATION.

- (i) Clean and wipe with an oily rag all unpainted steel surfaces.
- (ii) Clean and lightly oil the range cam, cam follower and cam follower spring to prevent rust.
- (iii) Lubricate the oiler hole in the clinometer bracket pivot and the three nipples on the underside of the sight gear body.

11. ANGLE OF SIGHT INSTRUMENT.

(a) DESCRIPTION

The angle of sight instrument consists of an angle of sight arm (with browpad, foresight and aperture backsight) to which a sight clinometer can be fixed. The bubble in the clinometer is reflected in a small mirror.

(b) USE

To take the angle of sight, the commander lays the instrument on the target and levels the bubble in the clinometer. The clinometer is then unclipped and fitted to its bracket without the setting being disturbed.

(c) MAINTENANCE.

The angle of sight arm should be kept clean and when not in use stowed in its correct position in the turret.

12. CALIBRATION (HE)

(a) INTRODUCTION.

To ensure that the guns of a unit can be concentrated quickly and accurately on a target when necessary, it is essential that the guns are calibrated. Calibration is the process of determining the accuracy of the gun compared either with a gun of range table performance (absolute calibration) or with another gun which is taken as standard (comparative calibration). Absolute calibration is not considered here. Guns vary in their performance chiefly on account of wear. The effect of calibration is to ensure that all guns in a troop or squadron shoot alike at a selected range.

(b) OCCASIONS.

17-pr guns should be calibrated:-

After 50 E.F.C. (provisional).  
Before a battle.

After every quarter of their life.



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(c) AMMUNITION

Ammunition of the same batch and sub-batch will be used to make shooting as consistent as possible.

(d) RANGE

Guns will be calibrated at a range of 4000 - 5000 yards.

(e) PREPARATION.

(i) An observer in a tank sited level with the expected m.p.i. will be appointed to observe and correct the fall of shot.

(ii) The squadron or troop commander will choose one tank to range.

(iii) The commanders of all tanks will check the adjustment of the range drum ( see paragraph 10(c) ) or if no AFV Sight gear is fitted the zeroing of the sight clinometer (see paragraph 8(c))

(f) METHOD.

(i) The observer will order the elevation in yards, e.g. 4500, or if no sight gear is fitted, in degrees and minutes for clinometer laying, e.g. 3 degrees 11 minutes.

(ii) The ranging tank commander will order three rounds to be fired at this elevation.

(iii) The observer will mark the m.p.i. and if necessary, move his tank level with it.

(iv) The second tank will then occupy the same position as the first. The commander, when ordered by the **observer**, will fire three rounds at the same elevation as the first tank.

(v) The observer will range the gun on to the mark until a round falls within 50 yards of the target (HE full charge) or 25 yards (HE reduced). Corrections will be made on the range drum (if fitted) or otherwise in turns and divisions of the handwheel.

(vi) When ranging is complete, the crew commander will slip the range drum to the original reading. If no range drum is fitted, he will level the bubble in the clinometer by turning the micrometer head and then slip the scales to the original reading.

(vii) Three more rounds will then be fired to check the m.p.i. If it is not sufficiently accurate, the above process (iv to vii) will be repeated.

(viii) All other guns will be calibrated similarly.



65 a.

13. CUPOLA, VISION NO. 1 Mk. 1 and 2.

(a) DESCRIPTION.

There are two types of vision cupolas (formerly known as all-round vision cupolas) the No. 1 Mk. 1 and No. 1 Mk. 2. The two Marks are distinguished by the hatches which on the Mk. 1 cannot be opened out flat and are NOT spring-loaded. The hatches on the Mk. 2. can be opened out flat and are spring-loaded. The vision cupola enables the crew commander to observe and control fire when the tank is closed down. The cupola is fitted with handlebars to assist the commander in rotating it, and can be locked in one of four positions.

Each Mark of cupola has 8 episcopes, 7 fixed and 1 tilting :-

- (i) The Mk. 1 has 8 No. 4 episcopes.
- (ii) The Mk. 2 has 7 No. 5 episcopes (fixed) and 1 No. 6 (tilting).

Three episcopes are placed close together at the front of the cupola, while the tilting episcopes are at the rear. For convenience the centre of the three forward episcopes will be called Position 1 and the remainder numbered from 2 to 8 in a clockwise direction as viewed from above. The tilting episcopes are in Position No. 5.

The No. 4 episcopes (Mk. 1 cupola).

The No. 4 episcopes consist of two prisms contained in a metal holder. The lower half of the forward side of the holder is hinged to allow the lower (or ocular) prism to be removed and is locked in position by two screws. The upper (or object) prism is fixed to the holder. The field of view of the episcopes is adjusted by means of a collimating screw in the centre of the hinged flap. The screw works in a conjunction with a spring plate inside the holder.

The No. 5 episcopes (Mk. 2 cupola).

The No. 5 episcopes Mk. 1 (of which there are 7 fitted and two spare) consist of two prisms contained in a metal holder. A black-out shutter is provided for the lower (or ocular) prism. Above this shutter on the holder is a collimating screw which is used to adjust the field of view. The forward side of the holder is hinged to allow the prisms to be removed and is locked in position by two screws. On the sloping side of the prism is a bracket with a recess into which the clamp on the mounting fits. A rubber sealing ring is fitted around the lip at the bottom of the upper (or object) prism to exclude moisture and dirt.

The No. 6 episcopes (Mk. 2 cupola).

The No. 6 episcopes (one fitted and one spare) consist of an object and ocular prism. The ocular prism slides into the object prism assembly but is not secured. The episcopes can be tilted fore and aft and is fitted with a handle for this purpose. The ocular prism on its sloping face is provided with a bracket and recess for clamping purposes.

(b) USE.

- (i) Ensure that the turret hatches on the Mk. 2 cupola are locked in the vertical position (to prevent any possible foul).
- (ii) Unlock the cupola.
- (iii) Rotate the cupola until the group of three episcopes is facing front.

Binoculars may be used for observing through episcopes.



65 b.

# THE BLACKOUT SHUTTERS (No. 5 episcopes only).

The blackout shutters should be used at night when it is desirable to prevent light escaping from the tank. It may also be necessary to blackout the episcopes (other than the forward group) at first and last light when the commander's powers of observation are likely to be impaired by other sources of light. The advantages of blacking-out must be weighed against the disadvantages of losing all-round vision.

## TO BLACK OUT .

Engage the finger with the lip on the shutter, pull out and down. The shutter is held in this position by two springs. To release the shutter, flick the lip to the rear.

Note :- On cupolas fitted with a binocular bracket (TD 29630) it will be impossible to operate the black-out shutters on the episcopes adjacent to the bracket except by first withdrawing the episcopes from their mounting.

## THE NO. 4 EPISCOPE (Mk. 1 cupola).

- (i) To dismount the episcopes.  
Hold the episcopes, unscrew the clamping screw located behind the brow-pad and remove the episcopes.
- (ii) To remove the ocular prism.  
Slacken the two knurled screws on each side of the holder, open the hinged flap and withdraw the prism.
- (iii) To replace the prism.  
Insert the prism lower end first into the holder, close the flap and tighten the screws.
- (iv) To mount the episcopes.  
Push the episcopes fully upwards into the mounting and secure it with the clamping screw.

## THE NO. 5 EPISCOPE (Mk. 2 cupola).

- (i) To dismount the episcopes.  
Hold the episcopes, turn the clamp anti-clockwise, press forward the clamp and remove the episcopes.
- (ii) To remove the prisms.  
Slacken the two securing screws on the holder, open the cover and remove the prisms.
- (iii) To replace the prisms.  
Insert the ocular prism into the holder, replace the object prism, close the cover and tighten the securing screws.
- (iv) To mount the episcopes.  
Push the episcopes fully upwards into the mounting, fit the clamp into the recess in the mounting plate and turn the clamp clockwise to lock it.

## THE NO. 6 EPISCOPE.

- (i) To dismount the episcopes.  
Hold the ocular prism, turn the clamp anti-clockwise and press it forward. Maintain hold of the ocular prism, pull down on the handles of the object prism assembly and remove the episcopes.
- (ii) To remove the prism.  
Slide the ocular prism out of the object prism assembly.



65 c.

(iii) To replace the prism.  
Push the ocular prism up into the object prism assembly.

(iv) To mount the episcopes.  
Push the episcopes fully upwards into the mounting. Hold the ocular prism and fit the clamp into the recess on the prism. Turn the clamp to lock it.

(c) TESTS AND ADJUSTMENTS.

ALIGNMENT OF FIXED EPISCOPES.

It is essential that the field of view of the fixed episcopes should be so aligned that an object appears in the same plane when viewed through each episcopes. This process is known as collimation. The tilting episcopes by its very nature is NOT adjusted.

(i) No. 1 Mk. 1 cupola.

Preparation.

1. Remove the seven fixed episcopes from their mountings, remove the ocular prisms and thoroughly clean the holder inside and out and the two prisms. Oil and dry clean the metal surfaces of the holder and of the prisms. Do NOT allow oil to get on the glass surfaces.
2. Unscrew the collimating screw until the end of the screw just protrudes on the inside of the flap.
3. Re-assemble episcopes and replace them in the cupola.
4. Ensure that the clamping screw engages correctly in the recess in the episcopes and that it is screwed up tightly.

Adjustment.

1. Select a suitable object which presents an approximately horizontal unbroken line of sufficient length to come within the field of view of two episcopes at the same time.
2. Observe the line through episcopes in positions 8, 1 and 2 in succession. Note in which episcopes the line appears to be highest.
3. Screw in the adjusting screw of this episcopes, until the horizontal line just starts to rise. This movement can be detected immediately if the line is observed through two episcopes simultaneously.
4. Screw in the adjusting screws of each of the other two episcopes until the horizontal line appears at the same level in all three.
5. Rotate the cupola and adjust episcopes in positions 3, 4, 6 & 7 in turn to bring the horizontal line as nearly to the same level as possible.

Hints and Tips.

1. The most likely trouble in adjusting episcopes will be caused by the ocular prism binding in the case. Binding may be caused by dirt and rust or a damaged or badly fitting case. Adjustment can still be made except in cases of severe damage, since by following the instructions exactly the ocular prism is moved by direct action of the screw and not by pressure of the spring.
2. If, by mistake, the adjusting screw is turned too far and, when it is unscrewed, the ocular prism fails to return, remove the episcopes, unscrew the adjusting screw, and, holding the episcopes with the adjusting screw downwards, tap it on the padding of the cupola hatch, re-insert and try again. If this fails, remove and strip the episcopes as described above.
3. If the clamping screw does not register in the recess in the episcopes it will work loose and the episcopes may drop out.
4. It is not easy to align episcopes in positions 3, 4, 6 & 7 very accurately. Adjustments can be best effected with the eyes as far away from the episcopes as possible. The important episcopes in positions 8, 1 and 2, can, however, be adjusted quickly, easily and accurately after initial preparation.



65. d.

5. After adjustment has once been made, removal and replacement of episcopes for cleaning should not necessitate complete re-adjustment provided that they are returned to their original position. It is therefore advisable to number each episcopes.

(ii) No. 1 Mk. 2 cupola.

Preparation.

1. Remove the seven fixed episcopes from their mountings, remove the prisms and thoroughly clean the holder inside and out and the two prisms. Oil and dry clean the metal surfaces of the holder and of the prisms especially the points of contact of the springs and prisms. Do NOT allow oil to get on the glass surfaces.
2. Unscrew the collimating screw until the end of the screw just protrudes on the inside of the holder.
3. Re-assemble the episcopes, ensuring that the ocular prism is pressed fully forward by the spring on the inside of the hinged cover. Replace the episcopes in their mountings.

Adjustment.

The method is the same as that for the Mark 1 cupola with the following exceptions :-

In sub-para. 2 for "highest" read "lowest".  
In sub-para. 3 for "rise" read "fall".

Hints and tips.

All the hints and tips given under Mark 1 cupola apply with the exception of sub-para. 3. The following additional paragraph applies to the Mark 2 cupola :-

If difficulty is experienced in engaging the locking clamp in replacing an episcopes in the cupola, press the bottom of the episcopes upwards and outwards.

(a) MAINTENANCE.

Wipe the outer glass surfaces with a clean cloth. If vision is still not clear, remove the episcopes and clean each prism thoroughly inside and out. Oil and dry clean the metal surfaces.  
Smear the outer glass surfaces lightly with anti-dim compound No. 2.  
Test the operation of the black-out shutters and especially the action of the springs.



## SECTION 7. - THE POWERED TRAVERSE SYSTEM.

Equipment required :- Challenger tank.  
Small screwdriver.  
Spanner 1/4" x 5/16".  
Stop watch.  
Oil can.  
Junior compressor.

### 1. INTRODUCTION.

To understand the system fully requires a comprehensive knowledge of electricity. It is not intended here to discuss in detail the electrical operation of the system.

### 2. DESCRIPTION.

#### (a) THE BATTERIES.

Current taken from the tank batteries controls the output of the generator.

#### (b) THE METADYNE GENERATOR.

The Metadyne generator is mounted on the forward side of the rear bulkhead in the top left hand corner and is driven by the tank engine through three "V" belts. The pull tension of the belts is maintained by a spring loaded jockey pulley. When the control handle is rotated, the generator feeds current to the traverse motor.

#### (c) THE SLIP RING ASSEMBLY.

The slip ring assembly is situated in the centre of the hull under the turret floor and is the means of conducting electrical current from the stationary hull to the rotating turret.

#### (d) THE MOTOR AND GEAR BOX.

The regulated current from the Metadyne is fed through the slip rings to the traverse motor which is secured to the floor of the turret. The motor is connected by a carden-shaft and universal couplings to the gear box which transmits the drive to a large gear-wheel fixed to the hull. This gear-wheel is concentric with the turret bearing and is supported on the centre stiffening rib of the hull. The motor is fitted with a magnetically controlled brake, which also serves the purpose of a clutch to couple the hand drive shaft to the non-driving end of the motor shaft when power is not being used.

A slipping clutch is incorporated in the gearing from motor to turret to protect the motor and gears from damage should the gun or turret foul during rotation.

Hand operation turns the motor through a bevel and worm reduction gear and thence turns the turret.

#### (e) THE CONTROL BOX AND CONTROL HANDLE.

The control box is mounted in the turret to the left of the gun and is connected by a cable and plug to the controller junction box situated just above the turret ring.

The control handle is a spade grip mounted on a spindle which projects through the face-plate of the control box.

Pivoted in the spade grip is the trigger lever which when pressed in closes contacts in the control box. When the control handle is rotated, the controller within the box causes the Metadyne to generate power and feed it to the motor which then drives the turret in the direction in which the control handle is turned.



A pointer on the control handle is used in conjunction with a degree scale on the box for testing purposes. The scale is marked 0-50 degrees in each direction. A guard attached to the top of the control box protects the control handle.

(f) THE CONTROL PANEL.

The control panel is wedge-shaped and is situated between two webs of the turret floor (RHS front). The panel is protected from damp and damage by a steel plate (with gasket) which is secured to the turret floor by counter-sunk screws. Mounted on the panel are the main contactor with its auxiliary contacts, suppression condensers and choke, stabilising transformer and a discharge rectifier. A terminal board is fitted at the bottom and leads from it to the slip rings, motor and controller junction box.

(g) FUZES.

Two fuzes are provided to protect the powered traverse circuit. These are situated on the cover of a junction box below the main switch box and driver's control board on the right side of the hull behind the driver's seat.

(h) THE HAND TRAVERSING GEAR.

The traversing wheel is situated below the control box. It is connected by shafting and a magnetically operated clutch to the non-driving end of the motor shaft.

Rotation of the handwheel turns the motor through a bevel and worm reduction gear and thence turns the turret.

When the power drive is in use, the clutch is automatically disengaged and the motor is then free to drive the turret by power.

The gear ratio of the hand traverse is 1144 to 1 or 20 minutes (approx). of arc of turret rotation for one complete turn of the handwheel.

3. USE.

(a) TO ROTATE THE TURRET BY HAND.

- (i) Disengage the turret lock by rotating the lever (left hand side of the turret) clockwise.
- (ii) Ensure that all obstructions inside and outside the turret have been removed. Elevate the gun sufficiently to clear the Normandy cowl, if fitted.
- (iii) Rotate the handwheel clockwise for right rotation and anti-clockwise for left rotation.

The hand traverse is used for fine laying on stationary targets.

(b) TO ROTATE THE TURRET BY POWER.

- (i) Ensure that the turret rotates freely by hand.
- (ii) Order the driver to start the tank engine and turn it at not less than 1000 r.p.m.
- (iii) Squeeze the trigger lever on the control handle and rotate the handle to left or right according to the direction of traverse required.
- (iv) To stop the turret, release the trigger lever or return the control handle to the central position.

The powered traverse is used for switching from one target to another and for tracking moving targets.

When the gun is laid in the desired direction fine laying on stationary targets can be achieved by small movements of the control handle. The powered traverse must not be operated for long periods when the tank is on a steep slope.

Note :- The gun must be elevated between 4 and 8 o'clock to clear the Normandy cowl.



68.

(c) TO OPERATE THE TURRET JACK.

If the turret jams, the turret jack is used to lift the turret a limited amount to enable the obstruction to be removed. The jack is operated by a cranked lever and ratchet situated in the hull (left hand side front).

(d) TO RAISE THE TURRET.

- (i) Release the lever holding strap.
- (ii) Press down the forward arm of the ratchet pawl.
- (iii) Move the lever down and up alternately and watch the indicator under the turret ring.
- (iv) Do not raise the turret beyond the limit marked on the indicator.

(e) TO LOWER THE TURRET.

- (i) Press down the forward arm of the ratchet pawl.
- (ii) Move the lever up and down alternately.
- (iii) Do not lower the turret beyond the limit marked on the indicator.
- (iv) Secure the operating lever.

4. TESTS AND ADJUSTMENTS.

TO TIME THE SYSTEM.

Equipment required :- Stop watch.

- (a) The tank should be on level ground and stowed for action.
- (b) Rotate the turret by hand and power as in 3(a)(b).
- (c) Run the tank engine at 1500 r.p.m. and rotate the turret at fast speed.
- (d) Time the turret over one complete rotation from a flying start. Time should not exceed 15 seconds. If it is appreciably more, report to an electrician.

ZERO ADJUSTMENT.

Equipment required :- Small screwdriver.

With the tank engine running at 1000 r.p.m. and the control handle central, press the trigger lever and look through the sighting telescope. If the sight moves right or left :-

- (a) Loosen the adjusting screw cover plate left of the control handle.
- (b) Tighten or slacken the adjusting screw in the control box until there is no movement of the sight.
- (c) Secure the adjusting screw cover plate.

5. MAINTENANCE  
CHECKING.

Check all electrical connections for tightness.

LUBRICATION.

Inspect the traverse motor gear box, hand traverse gear box and main turret gear box for leaks and top up if necessary with Oil 30 HD.  
Lubricate the following parts :-

Turret guide rollers	-	8 nipples	-	Grease No. 1.
Turret traverse indicator	-	1 nipple	-	Grease No. 1.
Main traverse gear box	-	3 nipples	-	Grease No. 1.
Carden shaft coupling	-	1 nipple	-	Grease No. 1.
Traverse motor rear	-	1 nipple	-	Grease No. 1.
Pivot ball	-	1 nipple	-	Grease CSL653A.

Obstruction in  
Tank battery  
interrupted :-  
(a) Fuse blown  
(b) Broken electrical  
(c) Battery d  
Fault in slip  
assembly.  
Internal fault  
dynamo.  
Mechanical f  
the drive.  
Faulty contr

Engine speed  
Slipping be  
Faulty contr

Slipping c  
Loose ele  
connection

Fault in  
Fault in



6. FAULT FINDING (POWER DRIVE).

SYMPTOM	CAUSE	ACTION
Turret will not traverse.	Obstruction in turret.  Tank battery supply interrupted :- (a) Fuze blown. (b) Broken or loose electrical connections. (c) Battery discharged. Fault in slip ring assembly. Internal fault in dynamos. Mechanical fault in the drive. Faulty control box.	Remove using turret jack if necessary.  Fit new fuze. Report to electrician. Examine and recharge. Report to electrician. Report to electrician.  Report to fitter. Report to electrician.
Traverse too slow.	Engine speed low. Slipping belts. Faulty control box.	Check engine speed. Report to fitter. Report to electrician.
Traverse erratic.	Slipping clutch. Loose electrical connections.  Fault in dynamos. Fault in gearbox	Report to fitter.  Report to electrician. Report to fitter. Report to fitter.

Jack is used to lift the turret  
on to be removed. The jack is  
situated in the hull (left hand side)  
S strap.  
of the ratchet pawl.  
alternately and watch the  
beyond the limit marked on the  
of the ratchet pawl.  
alternately.  
and the limit marked on the  
stowed for action.  
in 3(a)(b).  
rotate the turret at fast  
tion from a flying start. If  
appreciably more, report to  
the control handle control  
ighting telescope. If the  
of the control handle.  
e control box until there  
ear box and main turret  
O HD.  
pples - Grease No. 1.  
pple - Grease No. 1.  
pples - Grease No. 1.  
ple - Grease No. 1.  
ple - Grease No. 1.  
ple - Grease OS16534



70.  
SECTION 8. - AMMUNITION.

1. GENERAL.

This Section except the last paragraph, deals with details of ammunition which should be known by the tank crew. The last paragraph provides additional information for instructors.

2. 17 pr. AMMUNITION (See Figure 7).

(a) DESCRIPTION.

SERVICE TYPES.

- (i) Cartridge QF 17 pr. shot APCBC/T Mark 1.
- (ii) Cartridge QF 17 pr. shot APDS/T Mark 1B.
- (iii) Cartridge QF 17 pr. shell HE/T Mark 1 or 2 (full or reduced charge).
- (iv) Cartridge QF 17 pr. shell HE/T Super HC which will supersede (iii).

SUBSTITUTE SERVICE.

- (i) Cartridge QF 17 pr shot APC/T Mark 1.
- (ii) Cartridge QF 17 pr. shot AP/T Mark 1.

TRAINING TYPES.

- (i) Cartridge QF 17 pr. shot practice Mark 1T.
- (ii) Cartridge QF 17 pr. shell practice HE/T Mark 1.

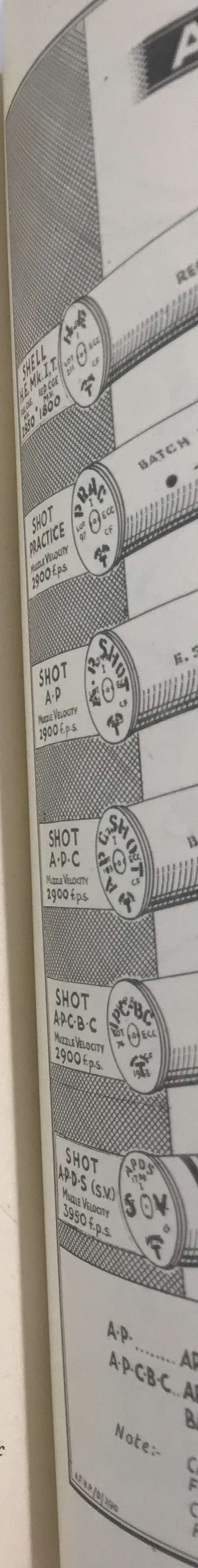
COMPONENTS.

17 pr. ammunition is of the QF fixed type consisting of a percussion primer, brass cartridge case, propellant charge and projectile with tracer. HE shells are fitted with a fuze. All components are issued, stowed and loaded as one complete round which is called a cartridge.

- (i) The cartridge case contains the propellant charge which drives the projectile from the gun and a base percussion primer which is the means of igniting the propellant. The propellant may be cordite or nitrocellulose NH. Cartridges are grouped in batches according to the propellant. The batch number is stencilled on the side of the cartridge case and on the boxes. Ammunition of the same batch gives more consistent shooting than that of different batches.
- (ii) The projectile is of two types, shot and shell. (See Figure 8) APCBC shot consists of a solid shot with an armour-piercing cap and ballistic cap. APDS (armour-piercing discarding sabot) consists principally of a light hard steel core enclosed in a special casing of aluminium known as the sabot which is discarded after the projectile leaves the muzzle. The HE projectile is a hollow steel body containing a filling of high explosive and is fitted with a nose fuze No. 254 Mk. 3 or No. 257. The shell is being modified to take a greater HE content and will be known as HE super high-capacity.

PACKAGES. (See Figure 9)

17 pr. ammunition is packed either in wooden or steel boxes which hold two rounds. The details of the ammunition are indicated clearly on the box. There are four kinds of boxes, two wooden and two steel. The steel box supersedes the wooden. APCBC ammunition requires a longer box than other types of ammunition.





# AMMUNITION

## PR.



### Definitions of Markings.

A.P. .... ARMOUR PIERCING.

A.P.C. ARMOUR PIERCING CAPPED.

A.P.-C-B-C. ARMOUR PIERCING CAPPED, BALLISTIC CAPPED.

APDS ARMOUR PIERCING, DISCARDING SABOT. (S.V. SUPER VELOCITY)

Note:- CARTRIDGE Q.F. 17 PR., H.E. SHELL, MK. 1, T, IS MADE OF H.E. SHELL, MK. 2, T, WITH FUZE NO. 244.

CARTRIDGE Q.F. 17 PR., H.E. SHELL, MK. 2, T, IS MADE OF H.E. SHELL, MK. 2, T, WITH FUZE NO. 257.

FIG. 7.

A.F.V.P./D/290



No. 244 or  
257 fuze

felt  
washer

Tracing cloth  
discs

C.E. Exploder

Paper tube

T.N.T.

Body

No. 13 Tracer

SHELL H.E.

A.F.V.P/D 300

# — 17 PDR. PROJECTILES —

Cap

Ballistic  
Cap

Penetrative  
Cap

Body

Driving  
Bands

Tracer  
Filling

A. P.

A. P. C.

A. D. C. B. C.

FIG. 8.



# 17 PR. AMMUNITION PACKAGES

**C274 MkI (WOOD)**  
CONTAINING 2 RDS. OF  
APC., AP, HE. OR PRAC.  
YELLOW BAND DENOTES  
PRAC.

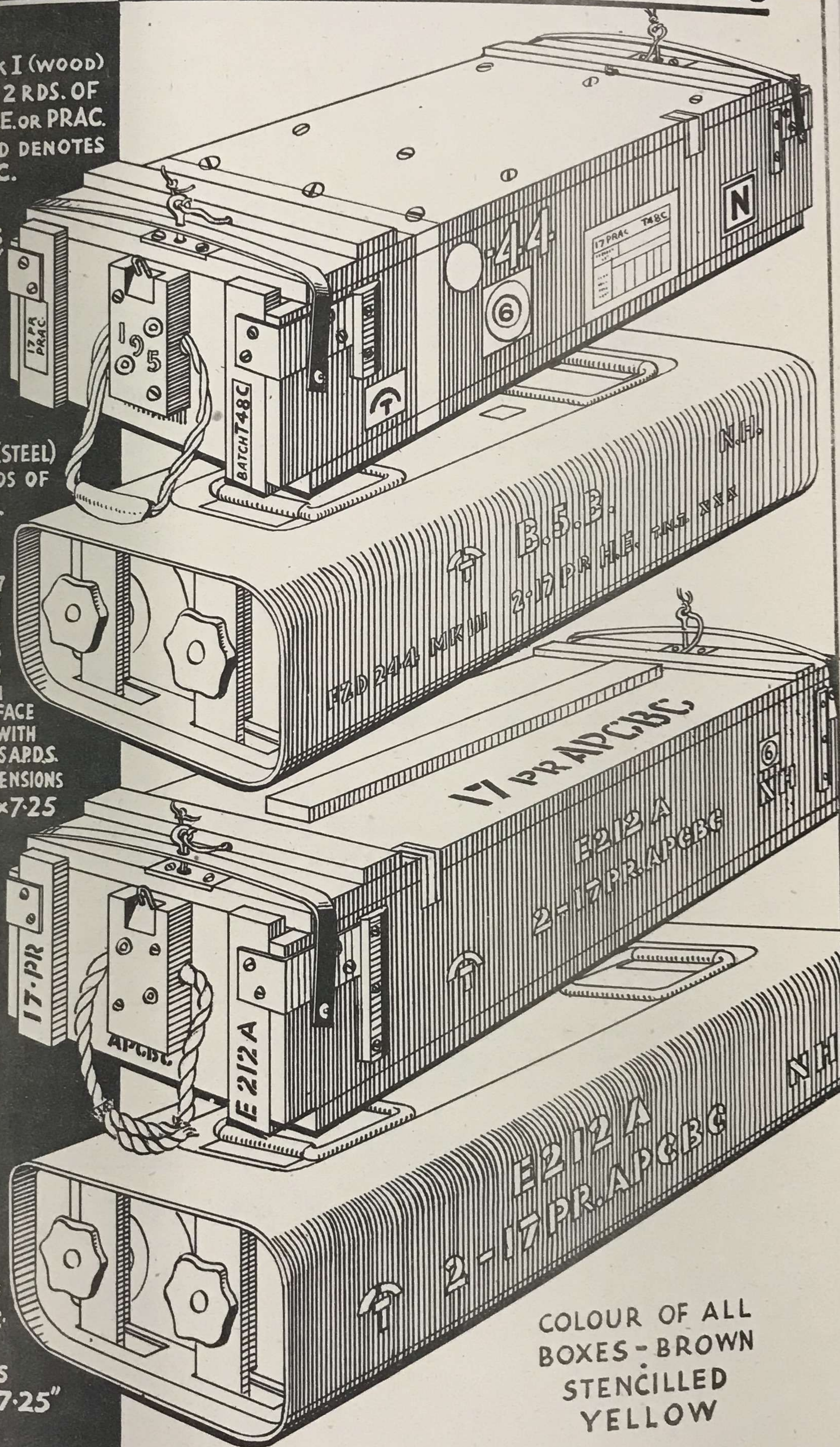
STOWAGE  
DIMENSIONS  
36.4" x 15"  
x 8.8"

**C288 MkI (STEEL)**  
CONTAINS 2 RDS OF  
APDS., APC.  
AP. OR HE.

APDS. IN CARD B9  
CONTAINER N°237  
OTHER TYPES IN  
c.c. N°86 MkI  
YELLOW LOCKING  
HANDLES AND  
YELLOW PATCH  
ON UPPER SURFACE  
OVERPRINTED WITH  
S.V.D.S. DENOTES APDS.  
STOWAGE DIMENSIONS  
36.6 x 12.87 x 7.25

**C310 MkI  
(WOOD)**  
CONTAINS  
2 ROUNDS OF  
A.P.C.B.C.  
STOWAGE  
DIMENSIONS  
39.625"  
x 14.375"  
x 8.375"

**C317 MkI  
(STEEL)**  
CONTAINS  
2 ROUNDS OF  
A.P.C.B.C.  
STOWAGE  
DIMENSIONS  
40" x 12.9" x 7.25"



COLOUR OF ALL  
BOXES - BROWN  
STENCILLED  
YELLOW



71.

RECOGNITION.

(i) Colour of projectile.

17 pr. projectiles are painted in distinctive colours according to standard British policy as follows :-

AP Shot .. .. .	Black with a white tip and one white ring around the nose.
APC and APCBC Shot .. .	Black with a white tip and two white rings about the centre.
APDS Shot .. .	Black with two white rings and one blue ring around the nose.

The addition of a red ring, either around the nose or centre of the projectile, indicates the presence of an explosive, i.e. tracer composition.

A brown ring on the projectile indicates that it is made of cast iron.

A yellow ring round the body of the projectile indicates Practice.

HE Shell .. .	Buff with a green ring around the body and a red ring or ring of red crosses towards the nose. The red crosses indicate 1st Grade TNT (shell filling).
---------------	---

(ii) Stencilling of the projectile.

The following details are stencilled on the body of the projectile :-

1. Design number of tracer.
2. 'T' when a tracer is fitted.
3. Monogram of firm or filling station.
4. Date of filling, month and year, e.g. 2/44.
5. Lot number in a ring.

(iii) Stencilling on the case.

1. On the side of the case.

The batch and sub-batch, e.g. E 43 C, and the propellant letters, e.g. WMT (for details of batching and sub-batching, see para. 9 below).

2. On the base of the case.

The nature of the round, e.g. AP or HE with or without 'T' for tracer.



72.

(iv) Markings on the fuze.

Number and mark of fuze, e.g. 244 Mk. 4.  
Factory initials.  
Lot number.  
Date of manufacture.

(v) Packages.

Colour of box = Brown with yellow stencilling.

Yellow band on wooden box = PRACTICE.  
Yellow locking handles and yellow patch  
overprinted SVDS on steel box = APDS.

Details on the box include number of rounds, type of  
ammunition, batch and sub-batch number, propellant letter  
and 'T' for tracer.

(b) USE.

TO REMOVE THE AMMUNITION FROM THE PACKAGE.

(i) Wooden box.

1. Pull out the pins from the locking bars.
2. Pivot the locking bar over the end of the box.
3. Remove the lid and ammunition.

(ii) Steel box.

1. Unscrew the knobs.
2. Turn the locking bars out of their recesses.
3. Remove the lid and ammunition.

TO PREPARE THE ROUNDS FOR FIRING.

All types are ready for firing except for removing the cartridge  
clip and fuze cap immediately before loading.

To remove the cartridge clip.

Raise the red painted arm and slide the clip off the rim of the case.

(c) MAINTENANCE.

GENERAL.

(i) Keep ammunition dry.

Dampness will cause the explosives contained in the primer  
and in the propellant charge to deteriorate.  
Misfires, hard-fires or erratic shooting may thus be caused.

of projectile.  
projectiles are painted  
standard British policy

AP Shot . . . . .

APC and APCBC Shot

APDS Shot . . . . .

The addition of a red ring  
of the projectile, indica  
i.e. tracer composition.  
brown ring on the proje  
cast iron.  
yellow ring round the

HE Shell . . . . .

Stencilling on the pro

The following details.

1. Design number of t
2. 'T' when a tracer
3. Monogram of firm
4. Date of filling,
5. Lot number in a r

Stencilling on the

1. On the side of t

The batch and su  
letters, e.g. W  
see para. 9 bel

2. On the base of

The nature of  
for tracer.



RECOGNITION.

(i) Colour of projectile.

17 pr. projectiles are painted in distinctive colours according to standard British policy as follows :-

AP Shot .. .. .	Black with a white tip and one white ring around the nose.
APC and APCBC Shot .. .. .	Black with a white tip and two white rings about the centre.
APDS Shot .. .. .	Black with two white rings and one blue ring around the nose.

The addition of a red ring, either around the nose or centre of the projectile, indicates the presence of an explosive, i.e. tracer composition.

A brown ring on the projectile indicates that it is made of cast iron.

A yellow ring round the body of the projectile indicates Practice.

HE Shell .. .. .	Buff with a green ring around the body and a red ring or ring of red crosses towards the nose.
	The red crosses indicate 1st Grade TNT (shell filling).

(ii) Stencilling on the projectile.

The following details are stencilled on the body of the projectile :-

1. Design number of tracer.
2. 'T' when a tracer is fitted.
3. Monogram of firm or filling station.
4. Date of filling, month and year, e.g. 2/44.
5. Lot number in a ring.

(iii) Stencilling on the case.

1. On the side of the case.

The batch and sub-batch, e.g. E 43 C, and the propellant letters, e.g. WMT (for details of batching and sub-batching, see para. 9 below).

2. On the base of the case.

The nature of the round, e.g. AP or HE with or without 'T' for tracer.



72.

(iv) Markings on the fuze.

Number and mark of fuze, e.g. 244 Mk. 4.  
Factory initials.  
Lot number.  
Date of manufacture.

(v) Packages.

Colour of box - Brown with yellow stencilling.

Yellow band on wooden box = PRACTICE.  
Yellow locking handles and yellow patch  
overprinted SVDS on steel box = APDS.

Details on the box include number of rounds, type of  
ammunition, batch and sub-batch number, propellant letter  
and 'T' for tracer.

(b) USE.

TO REMOVE THE AMMUNITION FROM THE PACKAGE.

(i) Wooden box.

1. Pull out the pins from the locking bars.
2. Pivot the locking bar over the end of the box.
3. Remove the lid and ammunition.

(ii) Steel box.

1. Unscrew the knobs.
2. Turn the locking bars out of their recesses.
3. Remove the lid and ammunition.

TO PREPARE THE ROUNDS FOR FIRING.

All types are ready for firing except for removing the cartridge  
clip and fuze cap immediately before loading.

To remove the cartridge clip.

Raise the red painted arm and slide the clip off the rim of the case.

(c) MAINTENANCE.

GENERAL.

(i) Keep ammunition dry.

Dampness will cause the explosives contained in the primer  
and in the propellant charge to deteriorate.  
Misfires, hand-fires or erratic shooting may thus be caused.

(ii) Keep ammunition  
ammunition,  
the direct  
consistent  
kept at the

(iii) Handle all  
The expl  
sensitive  
Brass car  
be protec

INSPECTION.

(i) If possi  
(ii) The prin  
(iii) The cart  
rust an

Cracks  
may be  
rejecte

(iv) The pro  
free fr

secure  
(v) The fu  
rounds  
fuzes

SMALL ARMS.

(a) DESCRIPTION.

TYPES.

(i) Cartridge  
Cartridge

(ii) Cartridge  
Cartridge

(iii) Cartridge

COMPONENTS.

Each round  
consisting

The name



73.

(ii) Keep ammunition COOL

Ammunition, especially fuzes, should be protected from the direct rays of the sun. Shooting will be more consistent if the rounds are kept at the same temperature.

(iii) Handle all ammunition confidently but with care.

The explosives in the primer or in the fuze are sensitive to undue shock. Brass cartridge cases are easily dented and should be protected from hard knocks and blows.

INSPECTION.

- (i) If possible, obtain ammunition of the same batch.
- (ii) The primer should be free from dirt and luting.
- (iii) The cartridge case should be clean, dry and free from rust and dents.  
Cracks at the mouth of the case not exceeding  $\frac{1}{4}$  inch may be ignored but cases cracked elsewhere must be rejected.
- (iv) The projectile should be clean, dry, well-painted and free from rust and cracks. The driving band must be secure and undamaged.
- (v) The fuze should be secure and free from exudation. Any rounds which show signs of exudation or have loose fuzes will be exchanged.

3. SMALL ARMS.

(a) DESCRIPTION.

TYPES.

- (i) Cartridge AP .30 Cal. M2.  
Cartridge tracer .30 Cal M1.
- (ii) Cartridge SA .303" ball Mk. 7 or 8.  
Cartridge SA .303" tracer Mk. 1, 2 or 3.
- (iii) Cartridge SA .45" or 9mm ball.

COMPONENTS.

Each round of small arms ammunition is of the fixed QF type consisting of:-

- A percussion primer.
- Propellant charge in a brass case.
- A bullet.

The name "cartridge" is given to the complete round.



## PACKINGS.

(i) .30".

.30"

Service ammunition is issued in 250 round web belts filled in the ratio of 4 AP to 1 tracer. Each belt is contained in a watertight steel box M1 or M2. An embossed outline of a cartridge either on the lid or the bottom indicates the lie of the cartridges in the box. Four of these boxes are packed in a wirebound wooden crate. For training, ammunition may also be issued in cartons and must be loaded into belts by Units themselves. A belt-filling machine is provided for this purpose.

(ii)  $.303''$ .

• This ammunition is packed in bulk in cartons contained in wooden boxes in varying quantities.

(iii) .45".

•45" American ammunition is packed in bulk in cartons contained in metal-lined wooden boxes as follows :-

20 rounds per carton, 100 cartons (2000 rounds) per box.

.45" British ammunition is packed in cartons and wooden boxes containing 1200 rounds.

(iv) 9 mm.

9 mm. ammunition is packed in bulk in cartons contained in wooden boxes as follows :-

50 rounds (hand-filled) or 48 rounds(machine-filled) per carton, 50 cartons per box, (2500 or 2400 rounds).

## RECOGNITION.

(i) Colour of bullet tip (American).

.30" and .45".

For purposes of recognition, American small arms cartridges have the tip of the bullet coloured as follows :-

AP            -    Black.  
Tracer       -    Red.  
Ball          -    Blain.

(ii) Colour of annulus (British).

.303", .45", and 9 mm.

British small arms cartridges are distinguished by the colour of the annulus.

Ball - Purple.  
Tracer - Red.

(iii) Stampings.

.30" and .45" (American).

The base of the cartridge is stamped with the factory initials and year of manufacture (last two figures), e.g. FA 42.



75.

.303", .45" and 9 mm. (British).

The base of the cartridge is stamped with the factory initials, year of manufacture (last two figures), mark and nature of the round, e.g.

HN 43 9 mm. Mk. 1Z.

The letter Z indicates that the propellant charge is nitro-cellulose.

Tracer cartridges are stamped "G".

(iv) Packages.

.30" and .45" (American).

.30" and .45" wooden ammunition boxes have a coloured vertical band placed centrally on the sides and a horizontal band at the ends of the box. The colours vary with the type of ammunition as follows :-

Ball	-	Red.
Mixed AP and tracer	-	Composite band blue, yellow and green (left to right).

.303", .45" and 9 mm. (British).

The colour of the boxes and the presence of shaped battens on the ends of the boxes no longer have any significance. All British small arms ammunition boxes will be stained brown and the use of battens will be discontinued. The contents originally were able to be identified by the raised letters and numerals on the ends of the boxes. Such letters and numerals are NOT being removed from boxes already bearing them.

G	-	tracer.
9	-	9 mm. ball.
4	-	.45" ball.

In future the contents are identified from the details stencilled on the box or printed on a label.

(b) USE.

.30".

Service ammunition in filled belts are packed ready for use.

.30", .45" and 9 mm.

.303" ammunition must be loaded into 100-round magazines, .45" into 20-round magazines and 9 mm. into 32-round magazines. See SAT Vol. 1, Pamphlet No. 6 Anti-aircraft Appendix II for filling the 100-round Bren magazine and SAT Vol. 1 Pamphlet No. 21 for filling carbine magazines.

(c) MAINTENANCE.

Boxes of small arms ammunition should not be opened until required for use. Liners should be examined for cracks, slits and other damage, and if damaged, rejected.

Carbine magazines should be kept clean and slightly oiled. Test the springs by pressing the magazine platform inwards.



(a) DESCRIPTION.

Bomb, ~~ML~~ smoke 2" bomb-thrower Mk. 1.  
Bomb, smoke bursting 2" bomb-thrower WP, Mk.3.

COMPONENTS.

The bomb consists principally of a tinned steel body containing the smoke composition and the tail unit which is finned and holds the ballistite cartridge which propels the bomb. The Mk. 1 bomb contains HCE composition (hexachlorethane) which when ignited by the flash from the propellant burns for approximately  $1\frac{1}{4}$  minutes. The Mk. 3 bomb is filled with white phosphorus (WP) and differs from the Mk. 1 in having a nose fuze (No. 151 or 151A) which detonates on impact and produces an immediate screen. The fuze is protected by a cap which must be removed before firing. There are two types of ballistite cartridge, 55-grain and 18-grain.

2" bombs are packed in cardboard containers secured together in a carrier of six containers. The carriers themselves are packed in green metal boxes No. B167 which holds three carriers (18 bombs).

British smoke ammunition is painted GREEN.

Green with a red ring (to denote that the bomb is filled).

Green with a white ring around the centre (to denote that the bomb is filled with WP).

55 grain - RED lettering ) visible when cartridge  
18 grain - BLACK lettering ) is in bomb.

Colour of steel box - GREEN.

The Mk. 1 bomb is ready for firing when removed from its container. Before loading the Mk. 3 bomb :-

- (i) Remove the adhesive tape securing the fuze cap.
- (ii) Remove the fuze cap.

- (i) Examine the bomb for dents, rust or burrs.
- (ii) Ensure that the fuze cap is secure on Mk. 3 bombs.
- (iii) Check that the cartridge retaining cap is screwed fully home. Otherwise a misfire will occur.
- (iv) Check that the tail unit is screwed tightly to the bomb to ensure that the flight is regular.

DESCRIPTION.

generator, smoke No. 8 Mk.

PACKINGS.

The generator contains smoke

PACKINGS.

The generators are packed

RECOGNITION.

The generators are colour

number and mark of genera

See Section 4, para. 3 f

containers.

DESCRIPTION.

TYPES.

No. 36 M (HE).

No. 80 Mk. 1 (WP smoke)

No. 81 Mk. 1 (WP and HC)

No. 83 Mk. 2 (Coloured

COMPONENTS.

(i) No. 36 M.

See SAT Vol. 1,

(ii) The No. 80 grena  
WP smoke compos  
the cylinder an  
the grenades an

(iii) The No. 81 (du  
the filling is  
screen while t

(iv) The No. 83 Mk  
in shape but  
required pri  
yellow smoke

PACKINGS.

(i) No. 36.

12 grenades  
keys and



## 5. SMOKE GENERATORS (TAIL SMOKE).

### (a) DESCRIPTION.

#### TYPES.

Generator, smoke No. 8 Mk. 5 or 6.

#### COMPONENTS.

The generator contains smoke composition which is ignited electrically.

#### PACKINGS.

The generators are packed in wooden boxes, 10 generators per box.

#### RECOGNITION.

The generators are coloured GREEN with black lettering indicating the number and mark of generator.

### (b) USE.

See Section 4, para. 3 for method of fitting the generators to the containers.

## 6. GRENADES.

### (a) DESCRIPTION.

#### TYPES.

- No. 36 M (HE).
- No. 80 Mk. 1 (WP smoke).
- No. 81 Mk. 1 (WP and HCE smoke), which will supersede the No. 80.
- No. 83 Mk. 2 (Coloured smoke).

#### COMPONENTS.

#### (i) No. 36 M.

See SAT Vol. 1, Pamphlet No. 13.

(ii) The No. 80 grenade consists of a tin-plated cylinder containing WP smoke composition, a striker mechanism screwed into the top of the cylinder and a detonator assembly which is not fitted until the grenades are required for stowage.

(iii) The No. 81 (duplex) grenade is similar to the No. 80 except that the filling is in two parts. One part is WP to give an immediate screen while the other is HCE to make the screen persistent.

(iv) The No. 83 Mk. 2 grenade (coloured smoke) is similar to the No. 80 in shape but has a different striker mechanism which does not require priming. The grenade may contain blue, green, red or yellow smoke composition.

#### PACKINGS.

#### (i) No. 36.

12 grenades are packed in a wooden box together with two base plug keys and a tin containing 12 igniter sets.



(ii) No. 80 Mk. 1.  
20 grenades (with striker mechanism assembled) each in a paper container and 20 detonators (No. 75 Mk. 1 or 2) in a tin box are packed in a box (P59 Mk. 2).

(iii) No. 81 and No. 83 Mk. 2.  
No. 81 and No. 83 Mk. 2 grenades are packed temporarily 24 in a green box (B.106). No. 81 grenades are packed in tiers while No. 83 grenades are packed in cardboard containers (3 grenades per container). Detonators for the No. 81 are packed in a separate box.

#### RECOGNITION.

- (i) No. 36.  
Dark brown with red band or red crosses.
- (ii) No. 80 and No. 81.  
Green with black lettering.
- (iii) No. 83  
Green with black lettering except that which denotes the colours of the smoke which is painted in white.

#### (b) USE.

No. 36.

For priming and throwing, see SAT Vol. I Pamphlet No. 13.

No. 80.

##### (i) To prime.

Screw off the striker assembly, insert the detonator into the tube with the cap uppermost and screw on the striker.

##### (ii) To throw.

Hold the striker lever securely against the cylinder, withdraw the safety pin and throw the grenade.

No. 81

As for No. 80.

No. 83 Mk. 2.

Coloured smoke grenades are used chiefly as signals to aircraft.

##### To throw.

As for No. 80.

#### (c) MAINTENANCE.

Before action grenades will be cleaned, examined, and if necessary, primed. The safety pin should be opened out sufficiently to prevent accidental discharge of the grenades but not to make withdrawal of the pins difficult.



79.

# 7. CARTRIDGES, SIGNAL AND ILLUMINATING.

## (a) DESCRIPTION.

### TYPES.

Cartridges, signal (red or green).  
Cartridges, illuminating.

### COMPONENTS.

The cartridges consist chiefly of a cardboard body containing gunpowder and a brass head with the percussion cap assembly.

### PACKINGS.

The cartridges are packed in tin boxes, each holding six cartridges.

### RECOGNITION.

The colour of the signal is denoted by the colour of the band around the cartridge :-

GREEN  
RED

A white disc on the closing cap indicates illuminating.

## (b) USE.

The cartridges are issued ready for loading.

## (c) MAINTENANCE.

Protect the cartridges from dampness since gunpowder rapidly deteriorates in the presence of moisture.

# 8. STOWAGE OF AMMUNITION.

## (a) 17 pr.

48 rounds are carried in the vehicle.  
DME Technical instruction A2014 dated November, 1944 lays down the bins in which the various types of ammunition are to be stowed. The bins are marked clearly in accordance with this instruction to ensure that the longer types of ammunition are stowed in their appropriate bins.

AMMUNITION BIN	BIN MARKING	REMARKS
18 rounds forward hull (see note) 1 round LH hull centre. 1 " RH " " 1 " LH forward turntable 1 " RH " "	"17 pr. ammunition APC or HE (short only)".	"(Short only)" stencilled in bright red paint. Remainder in black paint.
3 rounds RH front turntable 3 " RH rear " 3 " LH front " 3 " LH rear " 6 " Hull, FC middle front. 5 " Hull, FC LH front- 3 " " " LH rear.	"17 pr. ammunition APCBC or APC or HE (long or short)"	Stencilled in black paint.

Note:- The 18-round hull bin is being replaced by a longer bin to take all types of ammunition.



It is probable that APDS ammunition will be stowed in the bins front centre LH rear, and LH front of the fighting compartment. It is intended to fit spring clips to these bins in place of the retaining straps.

(b) .30" BROWNING.

3750 rounds (15 boxes of 250 rounds).

The boxes are stowed as follows :-

- 6 - on turntable floor.
- 2 - under gunner's seat.
- 3 - in pannier LH front.
- 2 - in pannier RH rear.
- 1 - in turret RH front.
- 1 - in box carrier on mounting.

(c) .303" BREN.

600 rounds (6 drum type magazines of 100 rounds).

The magazines are stowed as follows :-

- 1 - turret RH front.
- 2 - turret RH rear.
- 3 - hull RH behind driver's seat.

(d) .45" THOMPSON.

320 rounds (16 box type magazines of 20 rounds) - turret LH

OR

9 mm STEN.

256 rounds (8 box type magazines of 32 rounds) - turret LH.

(e) 2" SMOKE BOMBS.

30 bombs (20 Mk. 1 and 10 Mk. 3).

The bombs are stowed as follows :-

- 22 (20 Mk. 1, 2 Mk. 3) - on turntable RH side of gunner.
- 8 (Mk. 3) - in container below telescope mounting.

Both bomb containers can be jettisoned from the tank if necessary.

(f) REAR SMOKE EMITTERS.

4 generators No. 8 Mk. 5 or 6 - in containers outside the tank rear.

(g) GRENADES.

12 (No. 36M, No. 80 (WP) Mk. 1, No. 81 (duplex) Mk. 1, No. 83 Mk. 2), in various proportions - in two boxes - turret LH.

(h) CARTRIDGES SIGNAL.

18 (red, green and illuminating) - turret RH front.

... ammunition is batched on the ...  
... important item which ...  
... according to the nature of ...  
... with the cartridge, let ...  
... of 17 pr. SHOT APCBC ...  
... round consists of ...  
... case Mk. 1 or 2 with ...  
... primer and 8 lbs. 2 ...  
... No. 9 Mk. 3 percussive ...  
... containing of cap compos ...  
... a gas seal after the cap ...  
... 12 grains of gunpowder. ...  
... the case and the thread ...  
... primer is stamped with ...  
... the letter "H" added to ...  
... repaired. A second re ...  
... letter "R". Two slots ...  
... fit a key for removal ...  
... the case empty Mk. 1 ...  
... is formed at the base ...  
... a means of extracting ...  
... The case is coned an ...  
... the projectile. A t ...  
... to receive the prim ...  
... is secured to the p ...  
... The propellant, whi ...  
... RH (non-hygroscopic) ...  
... a muzzle velocity ...  
... crumpled sheet of ...  
... is ins ...  
... The type of prope ...  
... packing. ...  
... The projectile, s ...  
... body, an armour- ...  
... windshield. A d ...  
... projectile which ...  
... projectile and ...  
... muzzle and to ...  
... is protected by ...  
... The clip No. 3 ...  
... are made to fi ...  
... of a catch whi ...  
... The centre of ...  
... clip is fitte



9. DETAILED DESCRIPTION (for information of instructors).

(a) 17 pr. (See Appendix B for statement of ammunition).

BATCHING.

17 pr. ammunition is batched on the propellant charge and sub-batched on the next important item which may be the fuze, the shell or the primer according to the nature of the round. Cartridges and packages are marked with the cartridge letter, a batch number and a sub-batch letter, e.g. B49C.

CARTRIDGE QF 17 pr. SHOT APCBC/T Mk. 1.

The complete round consists of the APCBC projectile Mk. 8, a brass cartridge case Mk. 1 or 2 with cartridge clip No. 37, the No. 9 Mk. 3 percussion primer and 8 lbs. 2 ozs. of NH 055 propellant.

- (i) The No. 9 Mk. 3 percussion primer consists of a copper cap containing QF cap composition, an anvil with coned plug to form a gas seal after the cap has been struck, and a magazine containing 12 drams of gunpowder. The primer is screwed into the base of the case and the threads sealed with luting. The base of the primer is stamped with the letter "Q" to denote QF cap composition. The letter "M" added to the Mark indicates that the primer has been repaired. A second repair will be indicated by the addition of the letter "R". Two slots in the base of the primer are designed to fit a key for removal and assembly.
- (ii) The case empty Mk. 1 or 2 is made of drawn brass. A stepped flange is formed at the base to position the round in the gun and provide a means of extracting the case or round. The case is coned and provided with a neck for the attachment of the projectile. A threaded hole is situated centrally in the base to receive the primer. The case contains the propellant charge and is secured to the projectile by four indents.
- (iii) The propellant, which weighs 8 lbs. 2 ozs. consists of nitrocellulose NH (non-hygroscopic, i.e. does not absorb moisture) and imparts a muzzle velocity of 2,900 ft/sec. to the projectile. A loosely crumpled sheet of foil, tin or lead, is inserted in the mouth of the case to reduce coppering. The type of propellant is indicated on the cartridge case and packing.
- (iv) The projectile, Shot APCBC/T QF 17 pr. Mk. 8 consists of a steel body, an armour-piercing cap (APC) and a ballistic cap (BC) or windshield. A double driving band of copper is fitted to the projectile which weighs 17 lbs. The tracer is integral with the projectile and is designed to begin burning within 200 yards of the muzzle and to last for at least 5 seconds. The tracer composition is protected by a celluloid cap and a disc of bakelised paper.
- (v) The clip No. 37 is made of brass and has four arms, three of which are made to fit the rim of the cartridge. The fourth is in the form of a catch which can be raised to remove the clip from the round. The centre of the clip is domed to protect the percussion cap and the clip is fitted with a fabric carrying handle.



82.

CARTRIDGE OF 17 pr SHOT APDS/T Mk. 1B. (See Figure 10).

The components other than the propellant charge and projectile are similar to those used with APCBC ammunition. The case is marked with two black rings near the base to indicate super velocity.

The propellant consists of 6 lbs. 12 ozs. of NH 033 and imparts a muzzle velocity of 3950 ft/sec to the projectile.

The super-velocity projectile which weighs 6 lbs. 12 ozs. consists of a front sheath, rear sheath, nose pad, core, base plate, driving band, sealing ring and sabot. (See Figure 11).

The front sheath, of mild steel, is ogive-shaped and functions as a shield or cover, to protect the core.

The rear sheath is adapted to receive the rear end of the core and is of high tensile steel, since it transmits the firing pressure to the core, and is thereby highly stressed.

The front and rear sheaths together give the core a good ballistic shape, enable it to be suitably supported in the gun and protect it on striking the target.

The nose pad of duralumin, is provided to position and retain the core lengthways in the front sheath.

The core of tungsten carbide is the part of the projectile which is to penetrate the armour.

The base plate of high tensile steel is adapted to clamp the shot and sabot together, carries the driving band and is the medium for securing the shot to the cartridge case.

The driving band of soft steel is provided to rotate and drive the projectile and also assists the sealing ring to check the gas escape.

The sealing ring of hard rubber prevents the escape of gas past the projectile.

The sabot of duralumin encases the projectile and supports the shot while firing. It is provided with an internal thread adapted to engage a corresponding right-handed thread in the base plate.

The tracer No. 22 Mk. 1 is fitted into a cavity formed in the rear sheath.

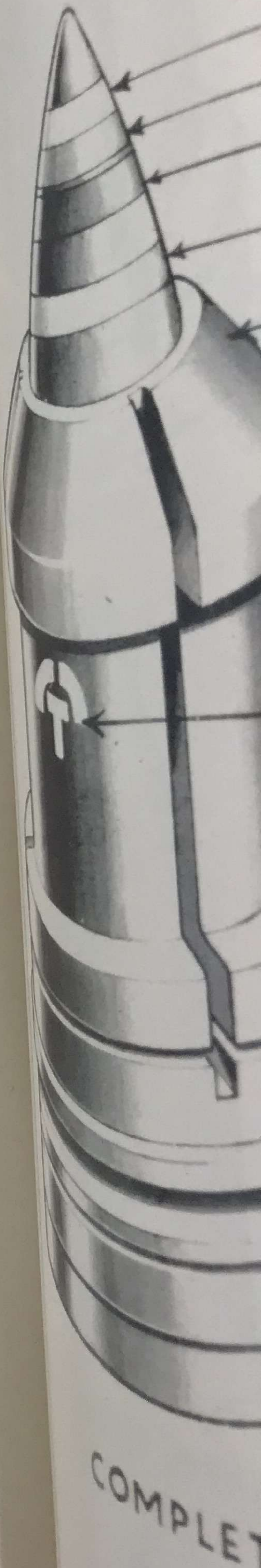
#### ACTION ON FIRING.

Fig. 12 shows a round loaded ready for firing.

On the initial shock of discharge the sabot is fractured at the external and internal grooves, and sets back on the solid ring at the rear end of the sabot, as illustrated in Fig. 12. During this setting back action the front end of the sabot rides up the ogive of the front sheath, thereby fracturing the connecting pieces between the three parts of the sabot. As the sabot rides up the ogive of the front sheath, prior to disintegration, its diameter is increased, thereby giving good centring of the shot in the gun bore.

As the projectile leaves the gun, the three parts of the sabot diverge from the trajectory of the main shot, as illustrated in Fig. 12. The angle of spread is usually not more than 6 degrees from the main trajectory. The base plate sub-assembly loses velocity rapidly and separates from the shot. The core proceeds on the main trajectory towards the target which is pierced, but the front sheath, nose cap, and rear sheath strip off on impact and the core alone completes the perforation and then disintegrates.

ARMOUR  
DISCAR  
(A  
M





# SHOT ARMOUR · PIERCING DISCARDING · SABOT. ( A · P · D · S ) Mk. I · B · T.

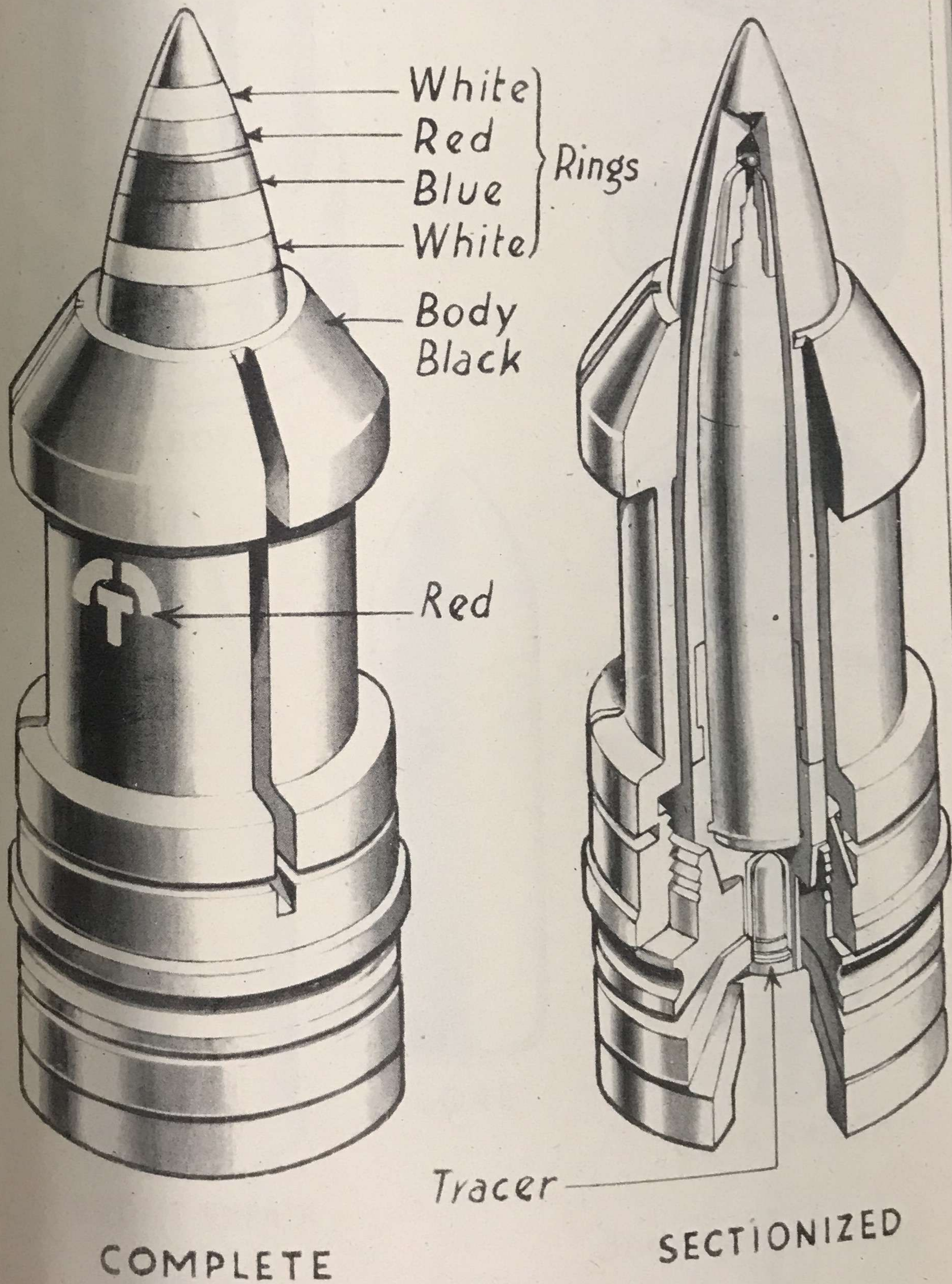
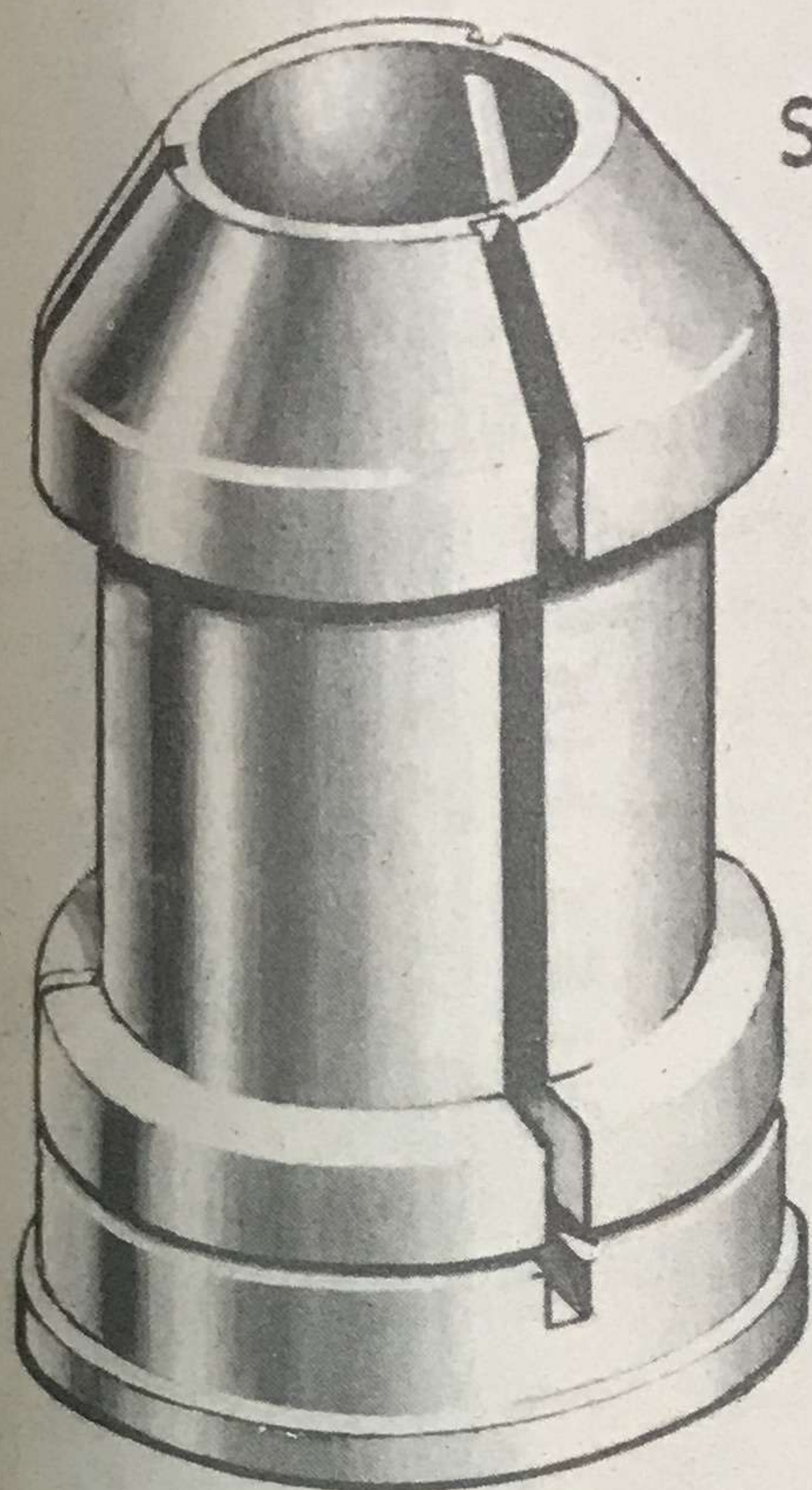


FIG 10



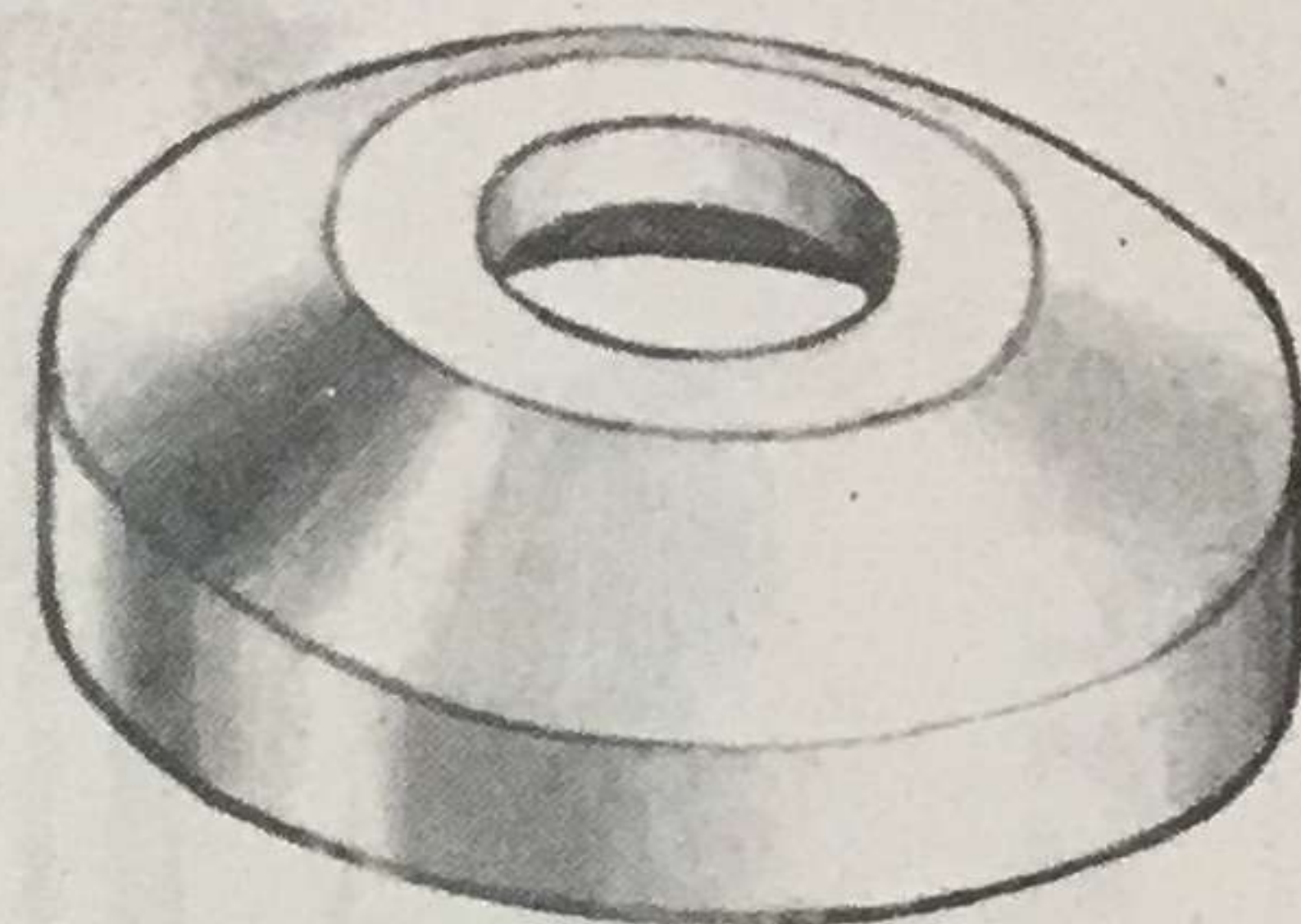
# COMPONENT PARTS OF SHOT A.P.D.S.



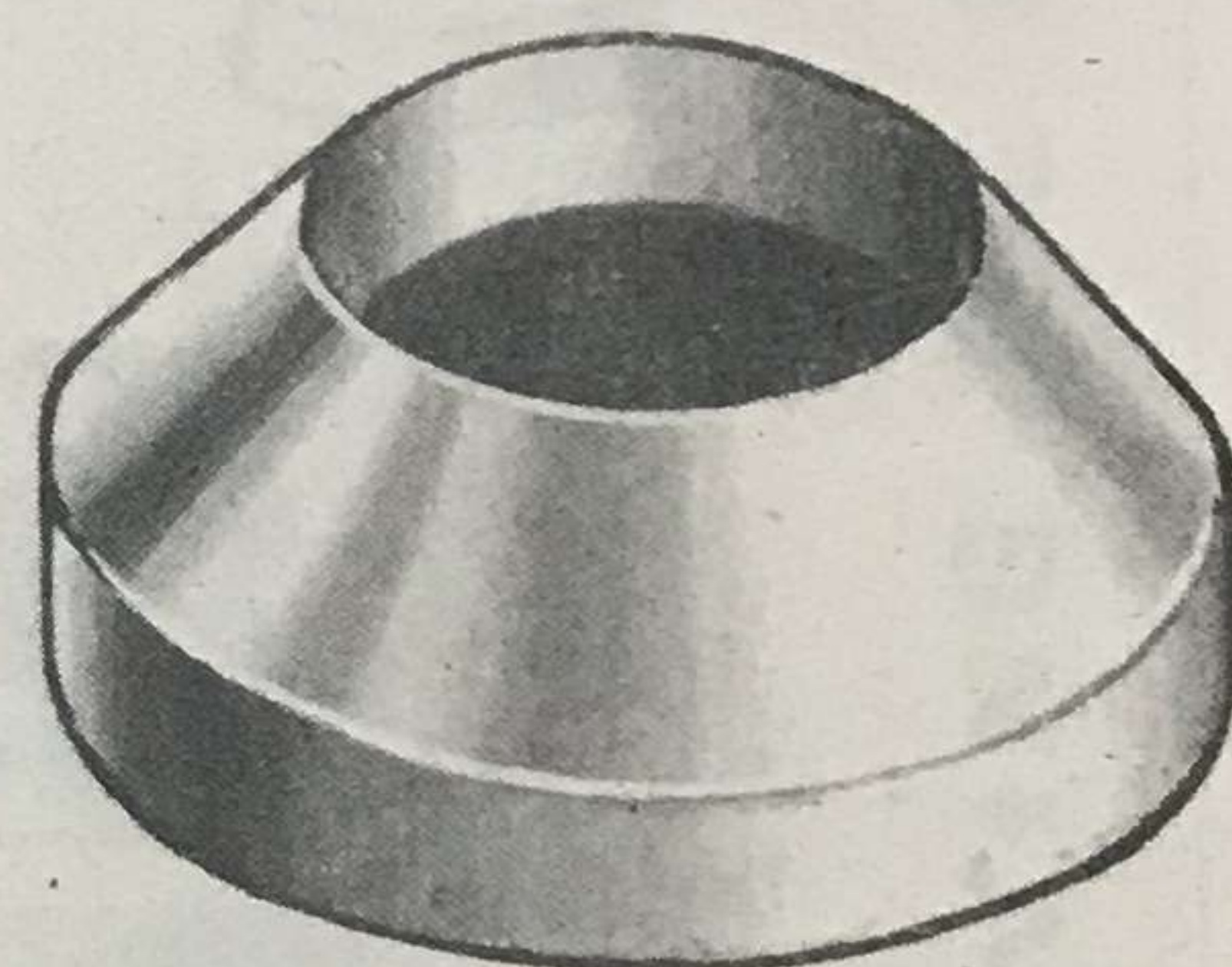
SABOT



BASE PLATE



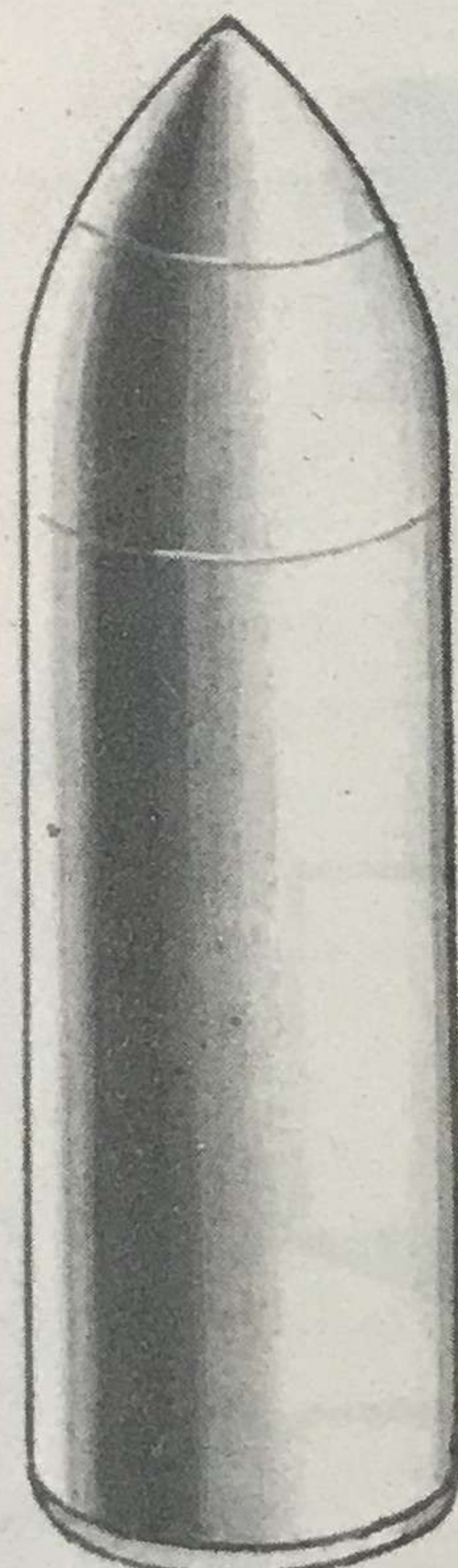
DRIVING BAND



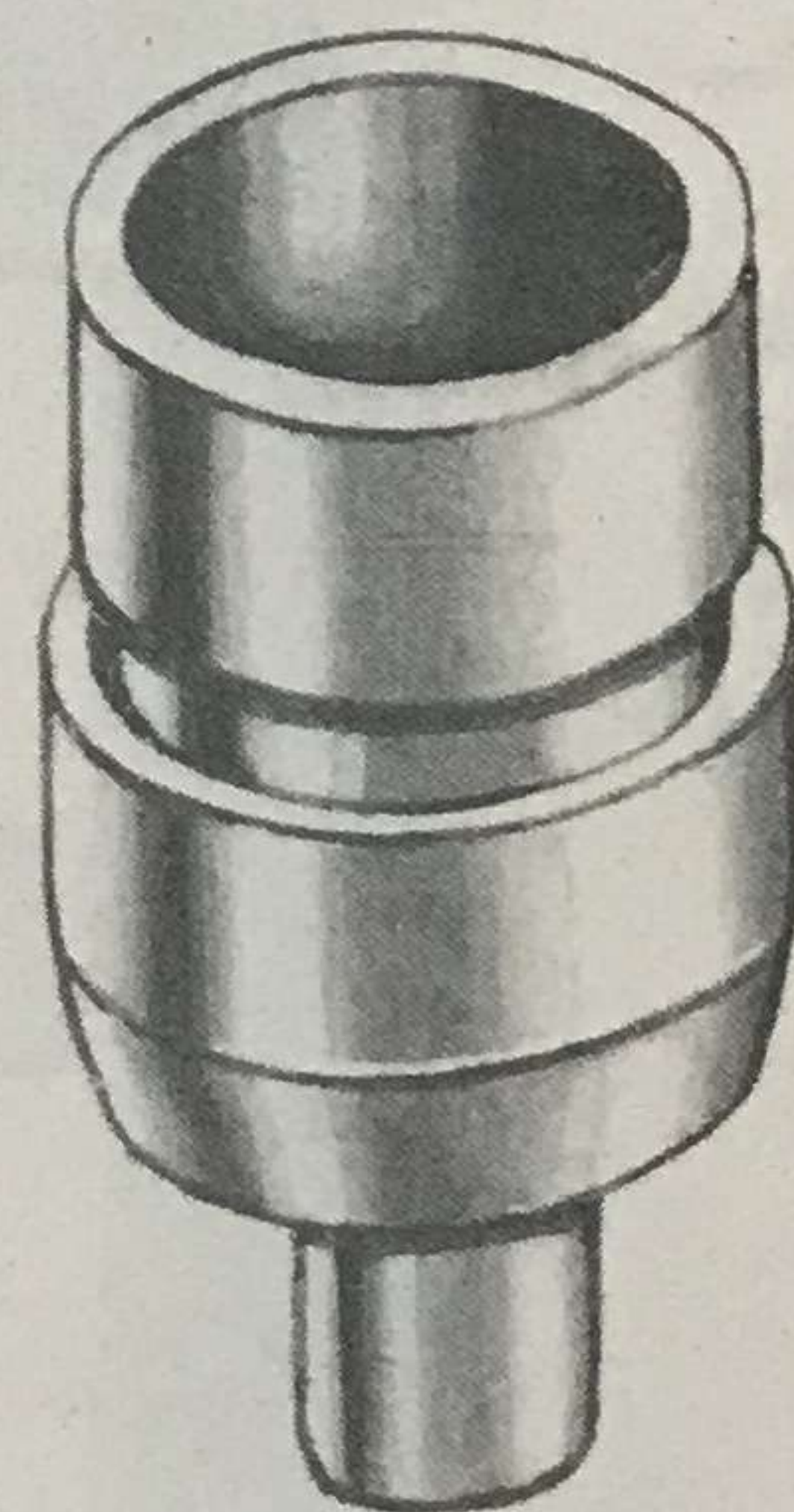
SEALING RING



FRONT SHEATH



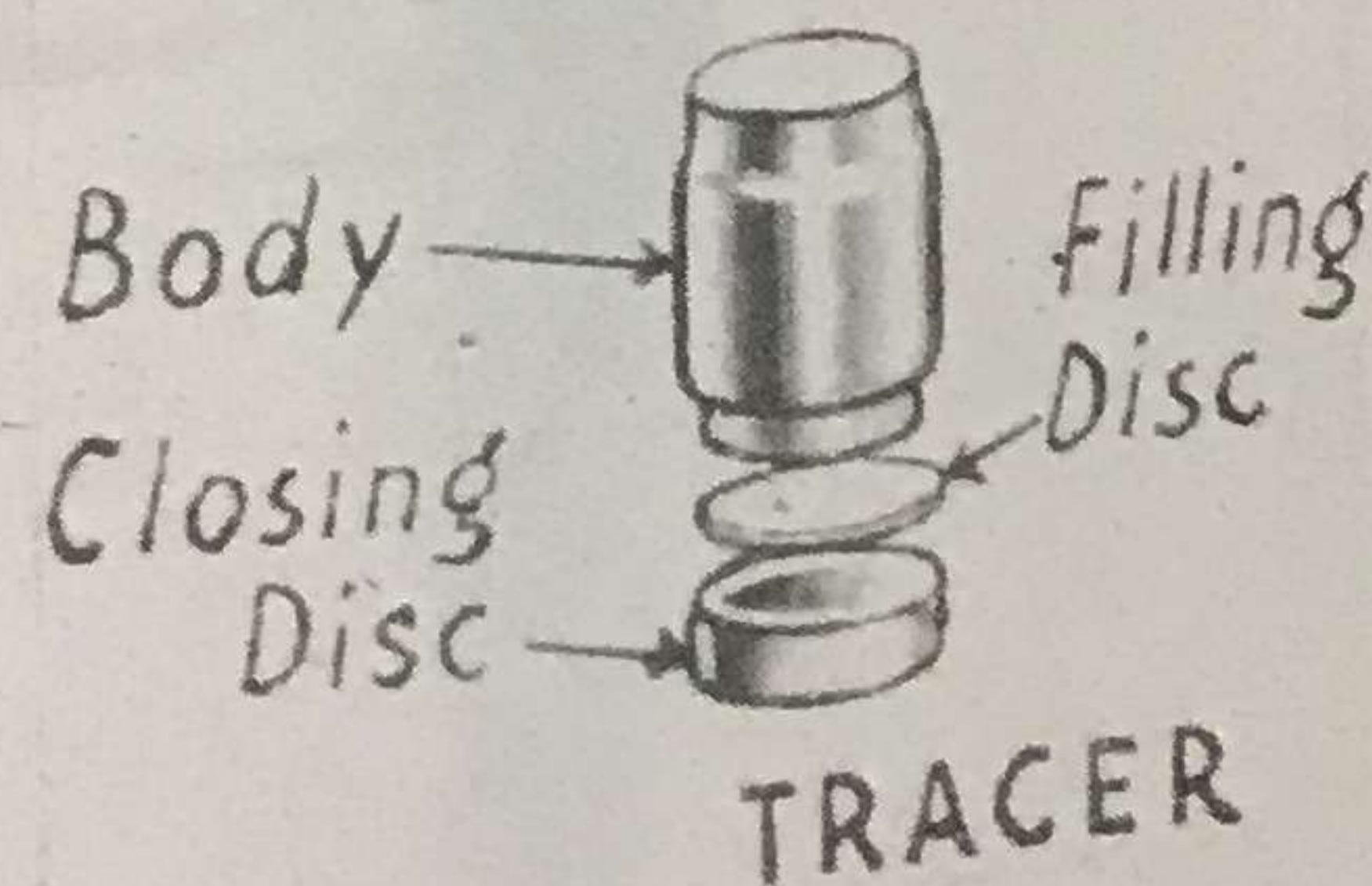
CORE



REAR SHEATH



NOSE PAD



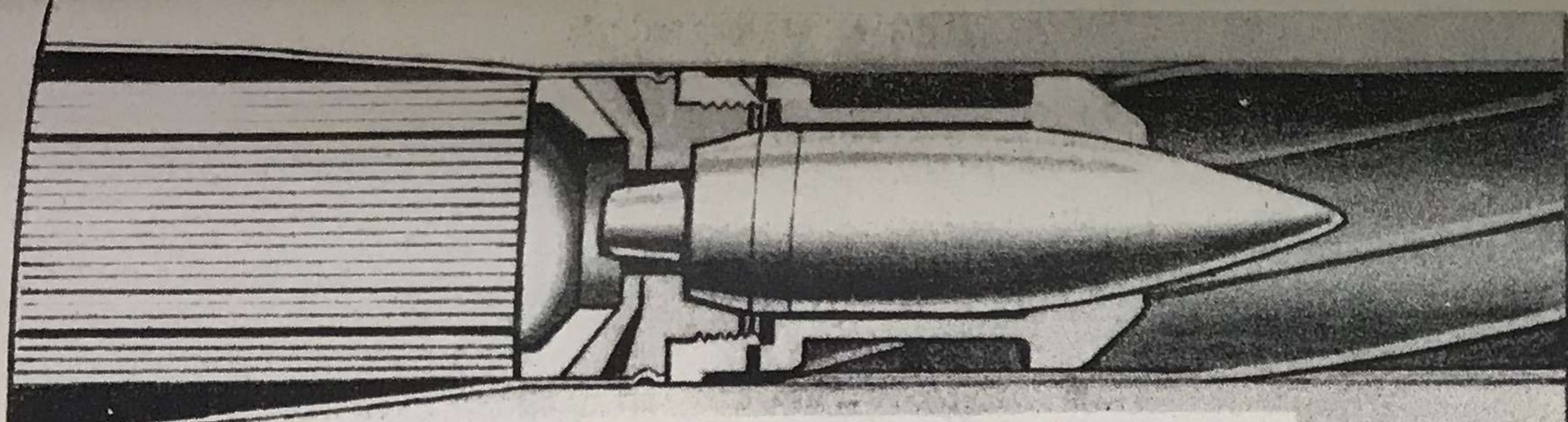
TRACER

AFVP/D/827

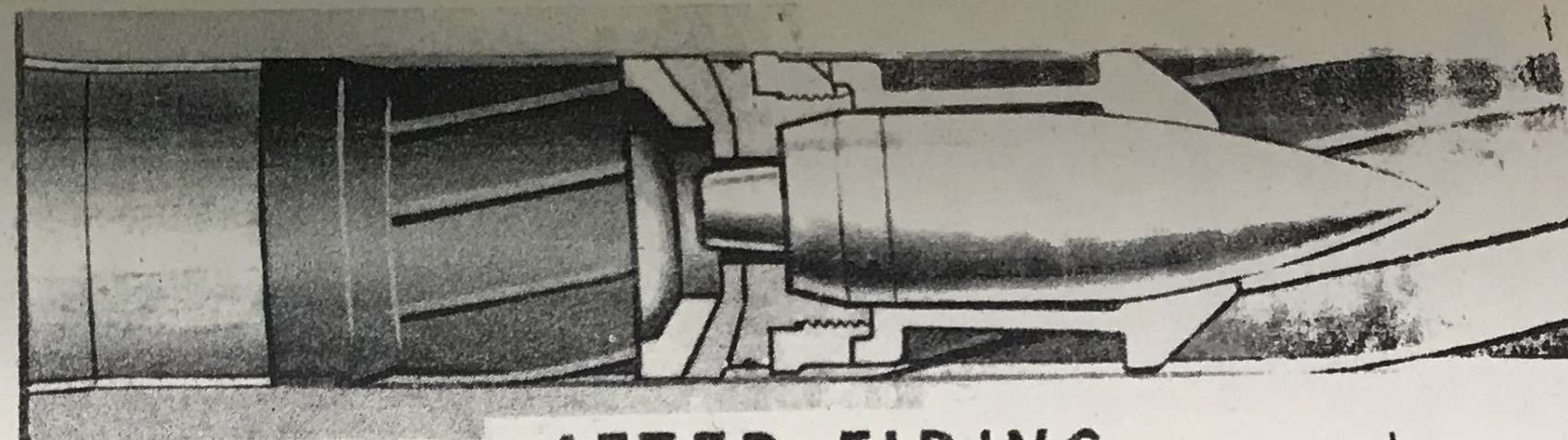
FIG. 11



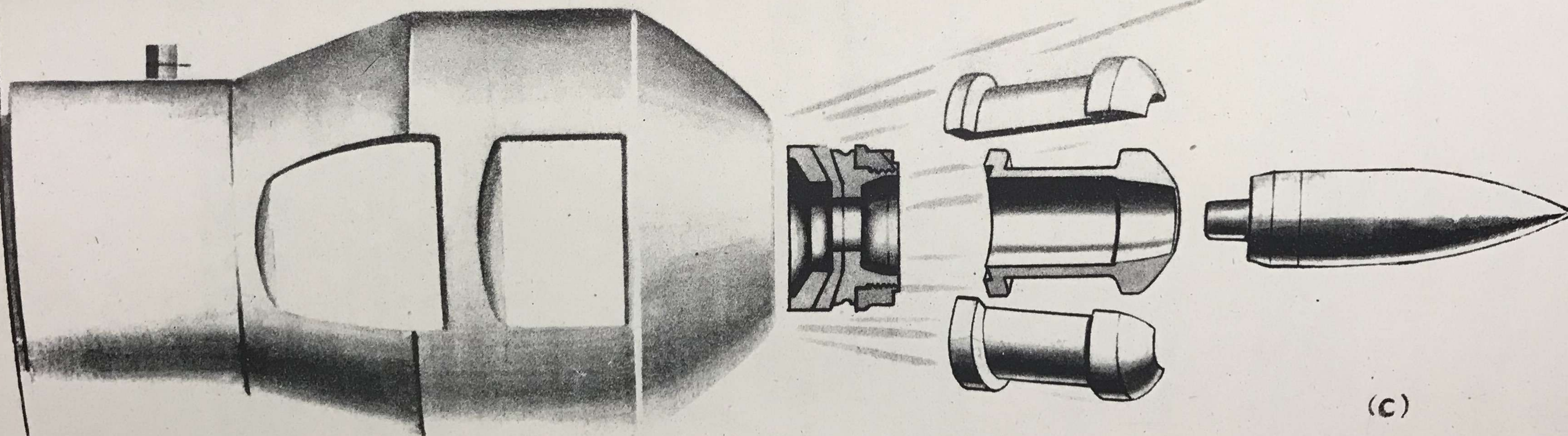
# ACTION ON FIRING A.P.D.S.



(a) LOADED & READY FOR FIRING



AFTER FIRING (b)



(c)

AFTER LEAVING THE MUZZLE

FIG. 12

EVF D/828



CARTRIDGE QF 17 pr. SHOT APC/T Mk. 1.

The complete round consists of the APC projectile with tracer, a brass cartridge case with cartridge clip, the No. 9 Mk. 3 percussion primer and a full charge of NH 055 propellant.

The primer, propellant and cartridge case are similar to those used with APCBC ammunition.

The projectile is of four types, Mk. 1T, 4T, 6T, or 7T. All types consist of a steel body and a flat-headed armour piercing cap. The various marks differ in the design of the tracer cavity and in weight. The Mk. 4 and 5 shot weigh exactly 17 lbs. while the others are very slightly lighter. The tracer and double driving band are similar to those on APCBC projectiles.

CARTRIDGE QF 17 pr. SHOT AP/T Mk. 1.

The components other than the projectile, are similar to APCBC ammunition.

The projectile is of three types, Mk. 2T, Mk. 3T or Mk. 6T. The projectile consists of a steel body with pointed nose. The Mark 3T weighs exactly 17 lbs. while the others weigh very slightly less. The marks differ in design of tracer cavity.

PRACTICE ROUNDS.

- (i) Practice shot is of two types, full charge with pointed projectiles and reduced charge with flat-headed projectiles. The case and primer are similar to those of service rounds. The full charge consists of 7 lbs. 14 ozs. of NCT 065 and gives the projectile a muzzle velocity of 2900 ft/sec. The reduced charge which is contained in a bag consists of 3 lbs. 9 ozs. of NH 033 and imparts a muzzle velocity of 1800 ft/sec. There are six marks of pointed projectiles of which Mk. 1, 3 and 6 are steel and the rest cast iron.

(ii) Practice shell.

A practice projectile Mk. 1T has been approved. It consists of a Mk. 2T HE shell filled with G12 gunpowder and fitted with fuze No. 199 and tracer and 1 igniter shell No. 11. No other details are available.

CARTRIDGE QF 17 pr. SHELL HE/T Mks. 1 and 2.

The Mk. 1 cartridge consists of the HC Mk. 2 projectile with fuze DA No. 244 Mk. 3 or 4, No. 13 tracer, cartridge case Mk. 1 or 2 with clip No. 37, a percussion primer No. 9 Mk. 3 and a propellant charge (full or reduced).

The Mk. 2 cartridge differs from the Mk. 1 in having the No. 257 fuze. A small proportion of shells will be fitted with the No. 125 time-fuze to enable guns to be paralleled by the air burst method.

The primer, case and cartridge clip are similar to those used with APCBC shot.

- (i) The propellant charge (full) consists of 6 lbs. 11 ozs. of NH 050, is designed to give a muzzle velocity of 2950 ft/sec. and gives the projectile a trajectory which matches that of AP shot. The reduced charge consists of 1 lb. 10 ozs. of cordite WM 017 and gives a muzzle velocity of 1800 ft/sec.



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- (ii) The projectile which weighs 13 lbs. 6 ozs. when filled contains a bursting charge of TNT and a "B" exploder together weighing 1 lb. 1 oz. The exploder consists of CE (composition exploding) contained in a paper tube. The projectile is fitted with two copper driving bands and is bored and threaded at the front to receive the fuze. A screwed socket at the rear of the shell holds the external tracer No. 13 Mk. 1.
- (iii) The fuze DA No. 244 Mk. 3 or 4 (See Figure 13) is a direct action fuze, designed to give a short delay.

The body is screw-threaded externally, below a flange to suit the fuze-hole in the shell. It is bored through and provided internally with screw-threaded recesses at the top and bottom. The exterior of the body is prepared for a fixing key and a set screw, the former above the flange and the latter into the upper recess.

The needle holder is screwed into the upper part of the body. It is bored centrally to allow a passage for the needle. Screwed into the underside of the needle holder is the upper detonator holder which contains an igniferous detonator.

The needle disc is corrugated and fits over the top of the needle holder. It carries the needle point downwards over the upper detonator. The needle disc is secured in position by the fairing which is screwed into the top of the body and is secured by a set screw. Pressed into the fairing is a safety cap which is removed before loading although it is stamped "FIRE WITH CAP ON".

The lower detonator holder has external screw threads to suit the lower recess in the body. It is bored centrally to contain a 5-grain lead azide detonator and communicates with the upper detonator holder by means of two small holes. Immediately beneath the detonator is the detonator plug which contains stemmed CE. A muslin bag containing 23 grains of G12 gunpowder is placed around the rounded portion of the holder inside the body.

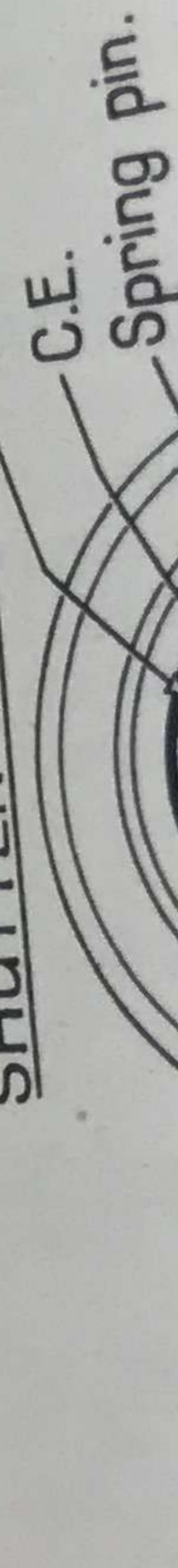
The magazine which is situated below the lower detonator holder contains the shutter in an upper recess and a CE pellet.

The shutter, which is accommodated in the upper recess of the magazine, is irregularly shaped and has upper and lower surfaces that are perfectly flat. Two holes are drilled through it from top to bottom, one being filled with stemmed CE, whilst the other fits around the hinge pin on which the shutter is pivoted. Paper tablets, secured by shellac, cover the top and bottom surfaces of the shutter, except the portion that has been drilled for the hinge pin. The function of the shutter is to seal the magazine against the flash of the detonator, should the latter ignite or detonate prematurely.

The shutter spring is secured at one end to a pin which, like the shutter hinge pin, fits tightly in a hole prepared for it in the bottom of the shutter recess. The spring, which bears against the edge of the shutter, is kept in its correct relative position by a brass wire pin. It ensures that the hole in the shutter containing CE shall not coincide with the centrifugal force set up by the rotation of the projectile is per minute when the shutter between 6,000 and 8,000 revolutions the spring, pivots on its hinge pin until the three holes containing CE are coincident.

No. 244 D.A. PERCUSSION FUZE-

SHUTTER CLOSED. Shutter spring.





# No. 244 D.A. PERCUSSION FUZE.

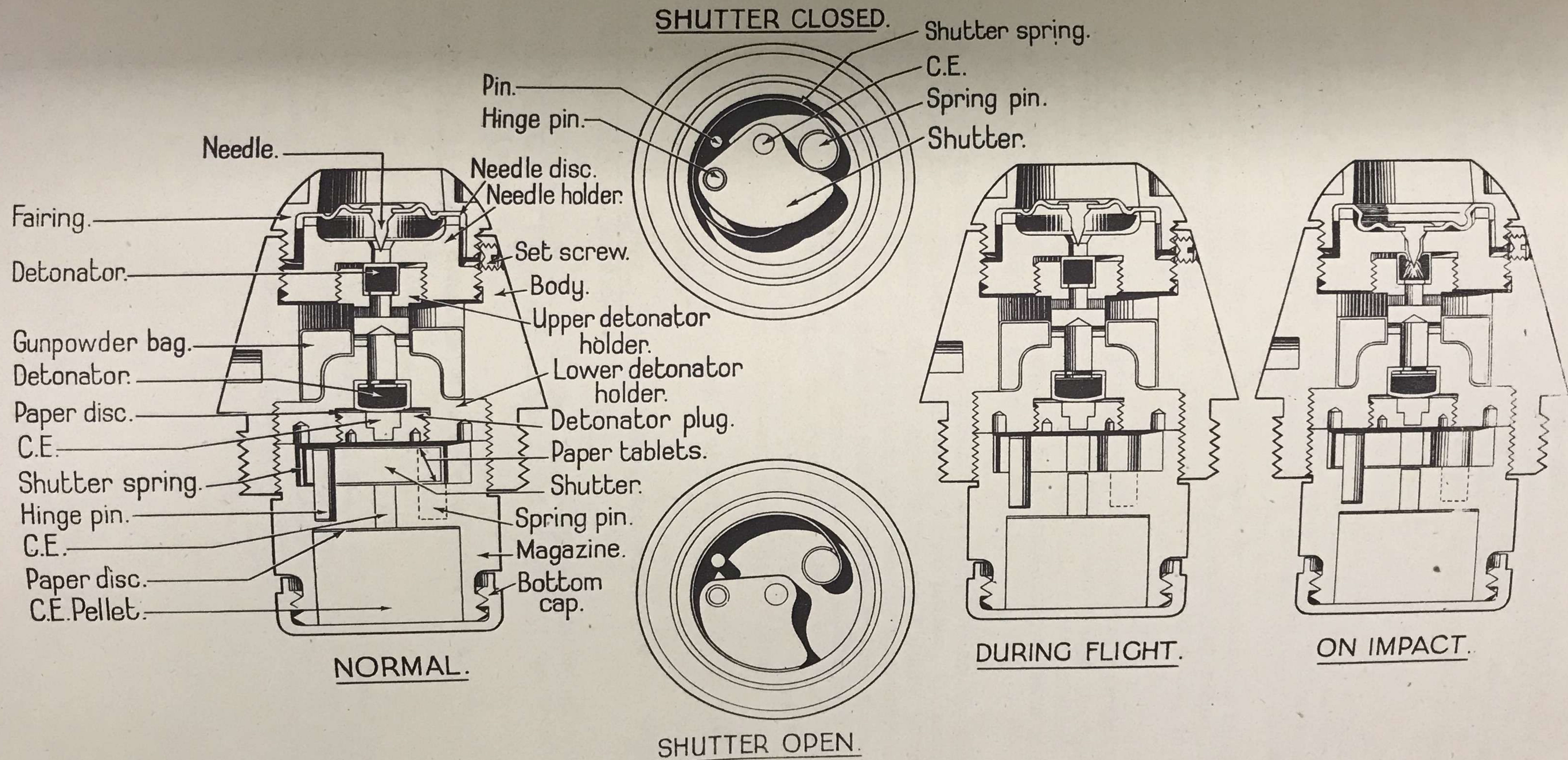


FIG 13



The bottom cap is screw-threaded internally to suit the threads at the bottom of the magazine. A paper disc is secured with shellac to the inside bottom of the cap which, when screwed to the magazine, seals the base of the fuze. It is further secured in position by crimping an upper flange, above the screw threads, in two or more places.

Action.

On firing, the shutter owing to its inertia sets back as the shell commences to accelerate up the bore, thus setting up friction which retards the action of centrifugal force and seals the fire channel to the magazine while the shell is in the bore. Acceleration ceases as the shell leaves the muzzle, and the friction set up between shutter and magazine is consequently reduced until the centrifugal force, due to the rotation of the shell, is able to move the shutter.

During flight the shutter pivots on its hinge pin, overcoming the restraining action of the shutter spring, and brings the hole filled with CE into alignment with similarly filled channels in the detonator plug and magazine, thus completing a train of CE from the lower detonator to the CE pellet.

On impact the needle disc is crushed inwards, the needle pierces the upper detonator and the resulting flash passes, by means of the boring and channels in the upper detonator holder, to the interior of the fuze body, where it ignites the gunpowder in the muslin bag. The flash from the powder passes by way of two holes to the central boring in the lower detonator holder, where it fires the disruptive detonator. The resulting detonating wave passes through the CE in the detonator plug, shutter and magazine to the CE pellet, which in turn detonates the shell filling.

The Mark 4 differs from the Mark 3 chiefly in that it is fitted with a 1.7 grain "A" detonator.

- (iv) The fuze DA No. 257 Mk. 1 is a re-designed version of the No. 244 and is superquick in action.
- (v) The No. 125 time-fuze is graduated up to 25 seconds but will be set at the factory to burst within the field of view of the telescope at 1500 yards (approx.).
- (vi) Tracer No. 13 Mk. 1 consists of a body and cap.

CARTRIDGE QF 17 pr. SHELL HE/T SUPER HC.

This cartridge differs from the present HE Mk. 1 and 2 cartridge in the projectile which contains a greater proportion of high explosive filling and is consequently known as "Super high-capacity". It will be fitted with the No. 257 fuze but an optional delay-superquick fuze is being produced.



86.

(b) .30" BROWNING.

The standard types of .30" Browning ammunition for service use are AP (M2) and tracer (M1). Ball is used for training.

AP.

The complete round consists of the bullet, cartridge case with percussion cap, and the propellant charge.

The bullet is flat based and consists of a gilding metal envelope containing a tungsten chromium steel core and a lead and antimony alloy tip.

The case is made of drawn brass and is provided with a cannelure for extraction. The neck is coned to hold the bullet.

The percussion cap is fitted into a recess in the base of the case immediately below the anvil. A flash hole connects the cap chamber with the propellant charge. The cap contains a pellet of cap composition which is covered by a shellaced disc of paper.

The propellant charge which is contained in the case, consists of a quantity of nitrocellulose powder.

TRACER.

The components, except for the bullet, are similar to AP.

The bullet is flat-based and consists of a gilding metal envelope containing a lead and antimony alloy tip while the rear is filled with red tracer composition and a small charge of igniting composition.

BALL.

Ball ammunition is of two types :-

The M1 cartridge bears the numerals 25 to 41 on the base and the M2 cartridge bears the numerals 38 or higher. The M1 bullet has a boat tail base and the M2 a straight base. The percussion cap, case and propellant charge are similar to those of the AP cartridge. The bullet consists of a gilding metal envelope with a lead and antimony core.

(c) .303".

.303" ammunition is used with the Bren LMG for A/A purposes. At least 20 per cent tracer should be used. The components are similar to .30" Browning ammunition except that the case is rimmed for extraction and the bullet core of the Mk. 7 cartridge has an aluminium tip.

(d) .45".

The manufacture of .45" ammunition is now restricted to the ball type. Tracer ammunition will be issued until present stocks are exhausted. Its manufacture was discontinued because the short range at which the carbine is fired makes the trace unnecessary. The use of tracer ammunition causes considerable fouling in the bore.

BALL.

The complete round consists of the bullet, cartridge case with percussion cap and the propellant charge.

- (i) The bullet consists of a gilding metal envelope with a lead and antimony alloy core.

The cartridge case is rimmed for extraction of the bullet.  
The percussion cap is fitted immediately below the anvil with the propellant charge composition.

The components of the round consist of the bullet, the percussion cap and the propellant charge.

The ball Mk. 12 or Mk. 22 complete round consists of the percussion cap and the propellant charge.

(i) The bullet consists of a gilding metal envelope coated with cupro-nickel alloy.

(ii) The case is made of drawn brass and is provided with a cannelure for extraction.

(iii) The percussion cap is fitted into a recess in the base of the case immediately below the anvil. A flash hole connects the cap chamber with the propellant charge. The cap contains a pellet of cap composition which is covered by a shellaced disc of paper.

(iv) The propellant charge which is contained in the case, consists of a quantity of nitrocellulose powder.

2" BOMBS.

There are two types of 2" bombs, the M1 and the M2.

M1 SMOKE 2" BOMB

The bomb consists of a nose cap to which an adapter is fitted. The adapter has a rear end screw drilled in the neck. The tail unit of the bomb is closed by a cap. Mark 1 bombs were devoid of all metal and were replaced by a wooden body. The bomb is filled with a smoke composition. The bomb is attached to the firing mechanism by a fuse.



87.

- (ii) The cartridge case is made of drawn brass and is provided with a cannellure for extraction. The mouth of the case is coned on to the bullet.
- (iii) The percussion cap is fitted into a recess in the base of the case immediately below the anvil. A flash hole connects the cap chamber with the propellant charge. The cap contains a pellet of cap composition.
- (iv) The propellant charge, which is contained in the case, consists of a quantity of nitrocellulose powder.

## TRACER.

The components of the round are similar to those of ball ammunition with the exception that the bullet contains a quantity of illuminating and igniting composition.

## (e) 9 mm.

The ball Mk. 1Z or Mk. 2Z cartridge is used in the Sten machine carbine. The complete round consists of the bullet, the cartridge case with percussion cap and the propellant charge.

- (i) The bullet consists of an envelope of either gilding metal or steel coated with cupro-nickel, which encloses a core of lead and antimony alloy.
- (ii) The case is made of drawn brass and is provided with a cannellure for extraction.
- (iii) The percussion cap is fitted into a recess in the base of the case immediately below the anvil. A flash hole connects the cap chamber with the propellant charge. The cap contains a pellet of cap composition.
- (iv) The propellant charge consists of 4.8 grains of nitrocellulose (indicated by "Z" on the base of the round). The Mark 2 propellant consists of 6 grains of N.C.

## (f) 2" BOMBS.

There are two types of 2" smoke bomb, the bomb ML smoke 2" bomb-thrower Mk. 1 and the bomb smoke bursting 2" bomb-thrower WP Mk. 3.

## BOMB ML SMOKE 2" BOMB THROWER Mk. 1.

The bomb consists of a tinned steel body closed at the front end by a nose cap to which a lifting strap is rivetted. The rear end is closed by an adapter. The forward end of the adapter is closed by a brass disc while the rear end screws into the tail unit. Four smoke escape holes are drilled in the neck of the adapter.

The tail unit of the bomb is formed by a central tube with vanes which has eighteen gas escape holes, contains a ballistite cartridge, and is closed by a cartridge retaining cap which is screwed and cemented. Mark 1 bombs were originally fitted with aluminium tails which are either devoid of all markings or embossed with "No. 1". The aluminium tail has been replaced by one of Mazak alloy (zinc) which has one fin daubed with red paint and embossed with "Z" or "No. 2". The bomb is filled with smoke composition (HCE) and a small quantity of priming composition.

The bomb is stencilled "2-in. B.T.I".



88.

On firing the flash from the cartridge fuses the closing disc in the adapter, passes to the priming and thence to the smoke composition. The expansion of the gas from the cartridge propels the bomb from the thrower. The bomb leaves a trail of smoke in the air.

BOMB, SMOKE, BURSTING 2-in. BOMB THROWER W.P. Mk. 3.

The bomb consists of a hollow tinned steel body open at one end and having a screwed spigot at the other to which is attached a tail unit of steel or Mazak alloy similar to that of the Mk. 1 bomb. The tail is embossed "No. 3" or "No. 4" on one fin.

The body of the bomb is filled with smoke composition (WP) contained in a container No. 4 Mk. 1. The front of the body is closed by the fuze DA No. 151 or 151A. (These fuzes are obsolescent).

The percussion fuze body is bored axially for the striker, and recessed at the base to house the shutter, disc and magazine, the latter being screwed into place. The top of the fuze is covered by a screwed safety cap marked "Remove before firing".

A recess parallel to the boring for the striker contains the detent and detent spring, the detent being retained in place by a stop. A boring at an angle to the boring for the striker is provided with a loose ball which, engaging in a recess in the striker, holds the striker to the rear, the striker spring under compression and the fuze at SAFE.

The shutter which is spring loaded carries a detonator. With the fuze at SAFE, the shutter spring is held compressed by the striker.

The disc is centrally drilled and filled with stemmed CE.

The magazine is filled with CE or Pentolite.

The container has a cap at the front end, which is blown in to enable the flash from the explosion of the magazine to ignite the smoke composition. The bomb is stencilled "2-in. MOR Mk. 3".

#### Action of the fuze.

When the bomb is fired, inertia causes the detent to set back against its spring, and the loose ball, when freed by the detent, to travel back in the angular boring. The detent spring then re-asserts itself and retains the loose ball out of action at the bottom of the angular boring. This action frees the striker, which is driven forward by its spring allowing the percussion cap to line up with the striker.

When the bomb strikes, the thin metal cap is forced in together with the head of the striker, the point of which detonates the percussion cap. The resultant explosion of the magazine charge bursts the body of the bomb and ignites the smoke composition in the container.

#### (g) BALLISTITE CARTRIDGES.

CARTRIDGE 2-in. BOMB THROWER (18 grain ballistite Mk. 1).

The cartridge consists of a varnished cardboard case with a rimmed brass head. In the head is a chamber fitted with an anvil and a copper cap. The cap contains 0.5 grain "A" detonating composition covered by a tin-foil disc. Next to the cap chamber is a gunpowder priming retained by a celluloid cup. The charge of 18 grains of ballistite is held between the celluloid cup and a cardboard disc and a felt wad. The whole assembly is covered by a cardboard disc inserted into the front of the cardboard case which is turned over to retain the disc.

2-in. BOMB THROWER  
similar to the 18 grain  
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25 per cent 18 grain.  
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See SAT Vol.  
No. 80 Mk. 1  
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the No. 75  
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A No. 63  
Mk. 1) ca  
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CARTRIDGE 2-in. BOMB THROWER 55 grain Mks. 1 and 2.

It is similar to the 18 grain Mk. 1 cartridge except in the charge which is greater.

SUBSTITUTION OF LONG RANGE (55 gr.) CARTRIDGES FOR SHORT RANGE (18 gr.) CARTRIDGES.

75 per cent of the bombs carried in the tank will have 55 grain cartridges and 25 per cent 18 grain. If it is desired to substitute the long range for the short range cartridge, attention is drawn to the following instructions :-

55 GRAIN CARTRIDGES WILL NOT BE USED IN BOMBS FITTED WITH ALUMINIUM TAILS.

If there is any doubt about the composition of the tail unit, no substitution will be made.

55 grain cartridges may be fitted either to Mazak or steel tails.

(i) Method.

Remove the cap retaining the cartridge without damaging the cap. If the cap is likely to be damaged during removal, another cap should be tried. Before replacing the cap, a small quantity of RD cement should be applied to the threads.

(ii) Marking of packages.

The words "18 GRS" or "17 GRS" will be painted out and replaced by "55 GRS". The two spring catches and hinges on the side of the package and the hinge of the lifting handle will be painted blue.

(h) TAIL SMOKE.

The No. 8 smoke generator Mk. 5 or 6 is used for tail smoke. The generator contains smoke composition SR269 and is ignited electrically by switches situated in the driver's compartment. This generator is similar to the No. 8 smoke generator Mk. 4 fired from 4-inch smoke dischargers. The Mk. 5 generator will not be fired from the 4-inch discharger. A later mark of generator is coming into production, the No. 8 Mk. 6 which can be used either as tail smoke or fired from the 4-inch discharger. Some generators may be stamped "GEN SMOKE No. 8 4" which indicates that the Mark 4 generator has been converted for electrical firing.

(i) GRENADES.

No. 36M.

See SAT Vol. 1 Pamphlet No. 13.

No. 80 Mk. 1 (WP).

This grenade is cylindrical in form and is tin-plated. The charging hole in the bottom is closed by a plug. In the top is a screw threaded recess and soldered to this is a brass detonator tube. The striker mechanism screws into the recess.

The smoke composition used is 13 ozs. of white phosphorus. The detonator assembly, which is not fitted until required for action is the No. 75 Mk. 1 or 2 and consists of a zinc alloy cap chamber, a copper cap containing priming composition and a length of No. 17 Mk. 1 safety fuze. A No. 63 Mk. 2 detonator is crimped to the fuze. The striker mechanism (No. 3 Mk. 1) carries the striker, striker axis pin and striker spring. The striker lever is retained by a safety pin which passes through the lever and housing.



90.

The striker mechanism is screwed into an adapter which is screwed and cemented into the recess on the top of the cylinder. The striker lever is rustproofed and coloured white. The grenade is 5.5 inches high and 2.4 inches in diameter.

No. 81.

The No. 81 grenade is similar to the No. 80 but the filling is in two parts. One part is WP to give an immediate screen while the other is HCE to make the screen more persistent. The grenade is fitted with striker mechanism No. 3 Mk. 1 or later No. 4 and the striker lever is rustproofed black. The operation of the grenade is similar to the No. 80 Mk. 1 grenade. The grenade has recently been modified by including a larger detonator (Mk. 2) and a more slowly burning composition which gives a screen lasting 39 seconds compared with 28 seconds on early types.

No. 83 Mk. 2.

The No. 83 coloured smoke grenade is designed for use from AFVs chiefly for signalling from ground to air. The No. 83 Mk. 1 is NOT suitable for AFVs. The body of the grenade is cylindrical and is filled with blue, green, red or yellow smoke composition. The top of the grenade is screw-threaded for the striker assembly and is pierced with 4 equi-distant smoke emission holes which are sealed by shellaced adhesive tape. An adapter and striker assembly No. 3 Mk. 1 or later No. 4 screws into the recess. The striker lever is rust-proofed black, to distinguish it from the No. 2 Mk. 1 striker assembly. The smoke lasts for 20-30 seconds.

(f) CARTRIDGES ILLUMINATING 1-in. J Mk. 2T, and CARTRIDGE SIGNAL RED OR GREEN MK.5T.

The above cartridges each consist of a charge of G12 gunpowder, a star with a quick match and muslin covering, a number of felt wads and a closing plug, all of which are contained in the cardboard case. The case has a brass head containing a percussion cap and 5 grains of detonating composition.

#### Action.

When fired, the detonating composition ignites the gunpowder charge which drives the star from the case. The explosion ignites the quick match which ignites the star after it has travelled about 200 yards. The star will burn for about 8 seconds.

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Tool  
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.30"  
Tel  
Cl

required:-

Live ammunition wi

To ensure that  
of the AFV in a

"PREPARE FOR ACTION".

On the command "Prepare  
before leaving harbour:

The driver will close  
engine is not already

The nearside loader  
cover from the 17-p  
the offside loader  
then remove the mu  
store them with the  
return to the tank  
the deflector.  
the battery box.  
ammunition is read  
The offside loader  
from the machine  
then ensure that  
ready for use an  
securing the def  
is closed and lo  
fastened in pos  
ammunition is r  
in opening and  
The gunner will  
take up the fi  
The crew comman  
for targets.

2. "ACTION".

On the command

The crew comman  
first round i  
The offside l  
he sees that  
the cocking  
When the 17-  
is vertical  
shout "Load  
re-load the  
to the right



SECTION 9

GUN DRILL

Equipment required:- 17-pr gun Mk.2 and coaxial .30" Browning machine gun mounted in an AFV or on an instructional mounting.  
Drill rounds, 17-pr.  
Tool removing jammed round, No.10.  
Lanyard cocking, No. 4 Mk. 2.  
.30" Browning ammunition box, belt and drill rounds.  
.30" Browning spares and tools.  
Telescope, sighting No.43 x3 ML Mk. 1 or 3.  
Cleaning material for both guns.

Note: Live ammunition will NEVER be used for drill purposes.

Object: To ensure that in battle the crew will handle the armament of the AFV in a quick and instinctive manner.

1. "PREPARE FOR ACTION".

On the command "Prepare for action", which will normally be given before leaving harbour:-

The driver will close his hatch and visor and start up if the engine is not already running.

The nearside loader will tip and stow his seat, remove the breech cover from the 17-pr gun, receive the machine gun breech cover from the offside loader and, taking the covers, leave the tank. He will then remove the muzzle covers from the guns and 2" bomb thrower and stow them with the breech covers in the outside bin. He will then return to the tank and assist the offside loader to raise and secure the deflector. He will open and stow the engine bulkhead plates near the battery box. He will ensure that the immediate supply of ammunition is ready for use.

The offside loader will tip and stow his seat, remove the breech cover from the machine gun and pass it to the nearside loader. He will then ensure that the immediate supply of machine gun ammunition is ready for use and will assist the nearside loader in raising and securing the deflector. He will then ensure that the turret door is closed and locked and that the empty case nets are securely fastened in position. He will ensure that the immediate supply of ammunition is ready for use. He will assist the nearside loader in opening and stowing the bulkhead plates.

The gunner will release the travelling and turret locks. He will take up the firing position and observe to the front.

The crew commander will take up a position of observation and look for targets.

2. "ACTION".

On the command "Shot(or shell) action":-

The crew commander will open the cover of the machine gun, place the first round in the belt under the transporter and close the cover. The offside loader will open the breech of the 17-pr gun, will lower the guard, cock the machine gun and raise the guard. When the 17-pr gun is loaded he will ensure that the loading platform is vertical, set the loader's safety switch (if fitted) to FIRE, and shout "Loaded". He will take a round from the bin and stand by to re-load the 17-pr gun. He will hold the round with the projectile to the right, extending his arms fully downwards against his legs.



92.

The nearside loader will load the 17-pr gun and ensure that the loading platform is vertical.

The loaders will share the responsibility of keeping the gun loaded but the offside loader will always re-set the safety switch and shout "Loaders clear guns".

3. "FIRE".

On the command "Fire":-

The gunner will fire either gun as ordered.

The loaders will feed the guns firing.

The crew commander will assist the offside loader in maintaining a supply of M.G. ammunition and in re-loading the machine gun.

4. "STOP"

On the command "Stop":-

The gunner will stop firing and keep the guns trained on the target area.

The loaders, with the aid of other members of the crew, will ensure that an adequate supply of ammunition is available, and will take any opportunity of clearing 17-pr cases from the turntable.

5. "GO ON"

On the command "Go on", the last target will be re-engaged.

6. "UNLOAD"

On the command "Unload":-

The loaders will return any live 17-pr rounds to the bin.

The crew commander will remove the belt from the machine gun and close the cover.

The offside loader will open the breech of the 17-pr gun. When he sees that the crew commander has removed the belt from the machine gun and closed the cover, he will pull back the cocking handle, release it and press up the finger piece of the trigger. When the 17-pr gun is clear, he will close the breech and ease the firing mechanism. After receiving the nearside loader's report, he will report to the crew commander "Guns clear".

The nearside loader will remove the 17-pr round from the chamber and re-stow it. He will then examine the bore and report to the offside loader "Gun clear".

The gunner, when guns have been reported clear, will traverse to the travelling position and engage the travelling and turret locks.

7. "CLEAR MACHINE GUNS"

To prevent rounds cooking-off in the machine gun during a lull in action, the order "Clear M.G." will be given:-

the machine  
will then  
the transporter  
"action" the offside loader  
cocking handle, and shout "Loaders clear guns".  
On this order,  
the 17-pr gun will be left  
held to the rear by the loader  
The loaders will inspect the  
can be kept trained in the target  
(17-pr).  
action by near  
pressure from  
set, set  
selector  
shout  
and keep the  
on the target.  
Re-cock  
cocking  
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IF THE GUN STILL FI  
gun trained  
target.  
Shout  
one  
AFTER ONE MINUTE  
IF THE C.A.P H.L.S  
the trigger.



93.

On this order, the machine gun will be unloaded.

The crew commander will then open the cover, place the first round in the belt under the transporter and close the cover.

On the command "Action" the offside loader will pull back and release the cocking handle, and shout "Loaded".

# 8. "CLEAR GUNS" (for range work only)

To minimise the occurrence of accidents during firing on ranges with inexperienced gunners, instructors (or others in charge of AFVs) will order "stop - clear guns". On this order, both guns will be unloaded.

The breech of the 17-pr gun will be left open, and the breech block of the machine gun held to the rear by the latch. If no latch is fitted, the breech block will be held to the rear by engaging the transporter behind the ramp. The loaders will inspect the bores and report "Guns clear". The guns will be kept trained in the target area.

# 9. MISFIRE DRILL (17-pr).

## Action by gunner

Release pressure from the trigger, set mechanical selector lever to SAFE, shout "Misfire" and keep the gun trained on the target.

Press the trigger.

## Action by nearside loader.

Re-cock the gun with the cocking lanyard.

## Action by offside loader.

Re-set the safety switch and shout "Loaded".

## IF THE GUN STILL FAILS TO FIRE

Keep the gun trained on the target.

Shout "Stand by for one minute".

## AFTER ONE MINUTE

Keeping the head a safe distance from the breech ring, examine the cap.

Open the breech sufficiently to allow the nearside loader to examine the cap.

## IF THE CAP HAS BEEN STRUCK

Shout "Cap struck" and open the turret door.

Close the breech while the door is being opened, unload and throw the round out of the tank.

Re-load.

Re-set the safety switch and shout "Loaded".

Press the trigger.



Action by gunner.

94.  
Action by nearside loader.

Action by  
offside loader.

IF THE CAP HAS NOT BEEN STRUCK

Shout "Not struck"

Exchange the striker case.

Close the  
breech.

Re-set the  
safety switch  
and shout  
"Loaded".

Press the trigger.

Note: If a misfire occurs with an HE round during training, the tank will be cleared of all personnel except the crew and will advance 300 yards from the firing point before the gun is unloaded and the round thrown out. Misfired rounds will be flagged and disposed of according to regulations.

#### 10. EXTRACTION OF JAMMED CARTRIDGES.

A cartridge may become jammed in the chamber for any of the following reasons:-

- (a) Over-gauge round.
- (b) Fouling in the lead or chamber.
- (c) Damaged round.

It is forbidden to hammer or tap a QF cartridge case while the primer is still in position, either to drive it home or to extract it from the chamber. If the cartridge is jammed in the chamber and cannot be extracted by leverage on the BML, it will be removed with the Key No.10. First remove the primer with the key, screw the key into the base of the cartridge case and withdraw the cartridge. Remove the key from the round. Rounds withdrawn by this method will be set aside for examination (during training only).

#### 11. NOTE ON BACK-FLASH.

Back-flash has been known to occur from the 17-pr gun but it is neither dangerous to the crew nor likely to impair their fighting efficiency in any way. Crews should be informed of it to ensure that they are not taken by surprise when it occurs. The conditions and frequency of its occurrence are difficult to ascertain, but methods of eliminating it by positive ventilation are being investigated.

#### 12. STOPPAGES (COAXIAL MACHINE GUN)

A stoppage of the coaxial machine-gun may be noticed first either by the gunner or the loader. When a stoppage occurs, the gunner(or loader) will shout "Stoppage." The gunner will NOT attempt to fire until the loader has cleared the stoppage and shouted "Loaded".

(a) Remove a round from the gun. The first round is the first round.

(a) Insert the belt without allowing the rounds to enter the feed block. Press the trigger. After the gunner has pressed the trigger, the instructor will order the "Gun stops". After the "Gun stops", the instructor will order "Loaded".

Misfire; weak charge  
friction; tight  
pocket in belt;  
hard extraction.

(a) Space in belt  
(b) Misplaced round in the belt.  
Torn belt. Give feed

Action by the loader

Cock the gun and shout "Loaded".

Tap the cover, pull the belt to the right and notice whether it moves. The feed (a) If the belt moves across shout "Loaded". If the belt does NOT move across block, reload and shout "Loaded".

Indication  
Gun stops.

the gun falls fire after I.L.



### 13. IMMEDIATE ACTION .30" BROWNING MACHINE GUN.

Note: When a stoppage occurs, the gunner will release pressure from the trigger and keep the gun laid on the target. When the loader reports "Loaded", the gunner will re-engage the target.

No.	Indication	Action by the loader	Probable Cause.	Method of preparation for instruction.	
				In the classroom or on vehicle with drill rounds.	On the range.
1.	Gun stops.	Cock the gun and shout "Loaded."	Misfire; weak charge friction; tight pocket in belt; hard extraction.	Load the gun and press the trigger. After the trigger has been pressed, the instructor orders "Gun stops".	Place a drill round in the belt. (Not as the first round).
2.	The gun fails to fire after the first I.A.	Tap the cover, pull the belt to the right and notice whether it moves. (a) If the belt moves across the feed block, reload and shout "Loaded". (b) If the belt does NOT move across the feed block, hold the belt where the rounds enter the feed block. Cock the gun. Either (i) <u>Feed takes place</u> Shout "Loaded". Or (ii) <u>Feed does not take place</u> Open the cover and inspect the belt. Straighten any misplaced rounds. If the belt is correct, inspect the feed mechanism and remedy any defects. Close the cover and reload and shout "Loaded".	(a) Space in belt (b) Misplaced round in the belt. Torn belt. Defective feed mechanism.	(a) Insert the belt without allowing the rounds to enter the feed block. Press the trigger. After the gunner has pressed the trigger, the instructor will order "Gun stops". After the I.A. the instructor will order "Gun will not fire". (b) Pull out the fourth round half an inch. Place the belt in the gun and load. Press the trigger. After the gunner has pressed the trigger, the instructor will order "Gun stops". After the I.A. the instructor will order "Gun will not fire".	(a) Remove a round at various intervals from the belt.  (b) Not set up.



No.	Indication	Action by the loader.	Probable Cause.	Method of preparation for instruction.	
				In classroom or on vehicle with drill rounds.	On the range.
3.	The gun still fails to fire after first and second I.A.	<p>Open the cover and remove the belt. Note whether the breech is open or closed.</p> <p>(a) <u>If it is closed.</u>  Unload and change the breech block. If no spare breech block is carried, change the defective part. Reload and shout "Loaded".</p> <p>(b) <u>If it is not closed.</u>  Hold the cocking handle to the rear and place the clearing plug in the chamber to remove the obstruction. Reload and shout "Loaded".</p>	<p>Defective breech mechanism, e.g. broken firing pin, cocking lever, sear or sear spring.</p> <p>Separated case in the chamber.</p>	<p>Load the gun and fire. After the trigger has been pressed, the instructor orders "Gun stops". After the first I.A. he orders "Gun will not fire", and after the second "Gun still won't fire".</p> <p>Insert the separated case. Load the gun. Open the cover and withdraw the breech block slightly to see whether the separated case has remained in the chamber. Support the rear of the round in the chamber and ease the breech block forward. Close the cover.</p>	<p>Place three drill rounds in the belt so that they will occur in the middle of a burst.</p> <p>Not set up.</p>

SECTION 10. - - - STATIONARY  
 SECTION 11. - - - STATIONARY  
 SECTION 12. - - - SHOOTING  
 SECTION 13. - - - SHOOTING  
 SECTION 14. - - - SHOOTING  
 SECTION 15. - - - FIRE DI  
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 99. 17 pr.  
 100. 17 pr.



P A R T II. - THE TECHNIQUE OF SHOOTING.

- SECTION 10. - GENERAL.
- SECTION 11. - STATIONARY SHOOTING.
1. 17 pr. AP and HE full charge (fired within AP ranges).
  2. 17 pr. APDS.
  3. 17 pr. HE full charge (fired beyond AP ranges) and reduced charge.
  4. MG.
- SECTION 12. - SHOOTING AGAINST MOVING TARGETS.
- SECTION 13. - SHOOTING ON THE MOVE.
- SECTION 14. - SHOOTING AT FIRST AND LAST LIGHT.
- SECTION 15. - FIRE DISCIPLINE.
- 
- APPENDIX "A" - LIST OF ARMAMENT TOOLS AND SPARES.
- APPENDIX "B" - STATEMENT OF 17 pr. AMMUNITION.
- APPENDIX "C" - PARTICULARS OF THE 17 pr. GUN (for reference).
- APPENDIX "D" - GLOSSARY OF TERMS.



SECTION 10. - GENERAL.

1. INTRODUCTION.

Part II deals with 17 pr. AP and HE shooting and machine-gun shooting.

2. POSITION OF VEHICLE.

In siting the tank the commander must always endeavour :-

- (a) To be hull down, head-on or at a slight angle (to present the thickest armour to the enemy).
- (b) To get the trunnions of the gun level.
- (c) To take advantage of the sun so that the enemy will be distracted by glare.
- (d) To note the direction of the wind and so position his tank that his observation will not be spoiled by smoke and dust from his own tank or from other tanks. Thus in a cross wind, it is often essential to stagger the tanks in a troop so that observation from each tank is unhindered.
- (e) To select alternative positions from which he can continue the fight.
- (f) To ensure that the tank is driven forward into position to reduce the number of rounds required to make the tank settle.

3. VENTILATION.

It is the duty of the crew commander to ensure that the turret is ventilated during firing. Inadequate ventilation may not only cause fatigue and impair the fighting efficiency of the crew but may prove dangerous. The means of ventilating is through two openings in the engine bulkhead. The plates which normally cover these openings are each secured by one screw and should be removed and stowed near the battery box during firing. The engine should be run at fast idling speed and the speed increased if the gun fumes do not disperse quickly enough. The ventilating fans in the turret roof should be OFF. If, during firing, the tank engine is not running, the ventilating fans should be switched ON.

4. TYPES OF FIRE.

In this book the technique of shooting will be dealt with as follows:-

- Stationary shooting.
- Shooting against moving targets.
- Shooting on the move.
- Shooting at first and last light.

It is emphasised that the technique of firing HE (full charge) which matches the velocity of AP is similar to AP within AP ranges. HE (full charge) when fired beyond AP ranges and HE (reduced charge) will be treated separately. Although APDS is a species of AP ammunition and the rules of AP shooting are applied to it, it will be treated separately in view of its special characteristics.

... (fired within 17 pr. ...)  
... (daily ten-minute quick ...)  
... (is it a Panther ...)  
... (decide to open fire, cons ...)  
... (fire at the range and angle ...)  
... (Penetration cards for 17 pr ...)  
... (the correct ammunition. ...)  
... (the centre of the target for ...)  
... (the first shot and if nece ...)  
... (information given ...)  
... (control necessary for ...)  
... (number of factors of which ...)  
... (is a high velocity weapo ...)  
... (medium velocity weapon wh ...)  
... (provided with the sight ...)  
... (targets by direct fire. ...)  
... (of the lenses, the degree of ...)  
... (of the graticule all af ...)  
... (the gun-piece enables the gunn ...)  
... (which hitherto demanded the ...)  
... (correcting fire varies ...)  
... (Both telescopes us ...)  
... (telescope is marked at in ...)  
... (make accurate correct ...)  
... (less accurate correctio ...)  
... (telescope is marked at in ...)  
... (intervals of 100 yards up t ...)  
... (corrections of 100 y ...)  
... (ranges over 1600 yards ...)  
... (CONTROL EQUIPMENT. ...)  
... (control equipment whic ...)  
... (sight are :- ...)  
... (The blade ...)  
... (The traver ...)  
... (AFV sight ...)  
... (Marked ele ...)  
... (Range find ...)



SECTION 11. - STATIONARY SHOOTING.AP AND HE FULL CHARGE (fired within AP ranges).

## (a) PRECEPTS.

- (i) Work as a team (daily ten-minute quickeners will raise the standard of teamwork).
- (ii) Identify your target (is it a Panther or a Tiger?).
- (iii) Before you decide to open fire, consider whether he is vulnerable to your fire at the range and angle at which he presents his armour to you. (Penetration cards for 17 pr. guns are included in the RAC Gunnery Wallet for this tank).
- (iv) Choose the correct ammunition.
- (v) Aim at the centre of the target for the first round.
- (vi) Hit with the first shot and if necessary correct to hit a vulnerable point with the next.
- (vii) Make use of the information given by each round.
- (viii) Use direct corrections.

## (b) FIRE CONTROL.

The teamwork and control necessary for success in the individual tank action depends on a number of factors of which the chief are the following :-

## THE GUN.

The 17 pr. gun is a high velocity weapon when firing AP and HE (full charge) and a medium velocity weapon when firing HE (reduced charge).

## THE SIGHTS.

The gunner is provided with the sighting telescope No. 43 x3 ML Mk. 1 or 3 for engaging targets by direct fire. The magnification of the telescope, blooming of the lenses, the degree of light transmission and the design and thickness of the graticule all affect observation. The use of the high-power eye-piece enables the gunner to engage targets and observe fire at ranges which hitherto demanded the use of high-power binoculars by the crew commander.

The method of correcting fire varies according to whether the graticule is moving or fixed. Both telescopes used in the Challenger have moving graticules.

The Mk. 1 telescope is marked at intervals of 400 yards range. The gunner can therefore make accurate corrections of 200 yards by halving the interval or less accurate corrections of 100 yards by quartering the intervals.

The Mk. 3 telescope is marked at intervals of 200 yards up to 1600 yards and at intervals of 100 yards up to 4000 yards. The gunner can therefore make accurate corrections of 100 yards at ranges up to 1600 yards and of 50 yards at ranges over 1600 yards.

## OTHER FIRE CONTROL EQUIPMENT.

Other fire control equipment which must be considered as auxiliaries to the gunner's sight are :-

- The blade vane sight No. 1 or twin blade sighting vane.
- The traverse indicator (if fitted).
- AFV sight gear No. 2.
- Marked elevating wheel.
- Range finder and angle of sight instrument.



100.

# RANGE TO TARGET.

Ranges for the 17 pr. gun may be classified as follows according to the type of ammunition :-

	AP	HE.
Short	Up to 800 yards.	Up to 2000 yards.
Medium	800 to 1500 yards.	2000 to 3000 yards.
Long	1500 to 2500 yards.	Over 3000 yards.

Crews must be well-trained in judging distance by visual means while crew commanders should also be trained in the use of range finders and range cards.

## THE TYPE OF TARGET.

The method of fire control will vary according to whether the target is :-

Conspicuous, upstanding and well-defined (e.g. enemy tanks or transport in the open).

Inconspicuous, ill-defined, small or hidden by natural or artificial means.

or Not seen at all by the gunner as may well happen even at very short range.

## (c) OBSERVATION OF FIRE.

### IMPORTANCE OF OBSERVATION.

OBSERVATION OF THE STRIKE, TRACE OR BURST IS THE BASIS OF TANK GUNNERY.

It is, therefore, essential that the gun be correctly shot-in (or zeroed when the equipment is available) to ensure that the gunner will hit the target at short range and under conditions where observation is impossible.

### RESPONSIBILITY.

Although the responsibility for observation lies chiefly with the gunner and crew commander, it is essential that all members of the crew be trained to assist in observation since in certain conditions it may be possible for one member of the crew, for example, the driver to observe when the others are still blind to the target. He will NOT volunteer information.

### FACTORS AFFECTING OBSERVATION.

#### (i) Consequences of firing.

Muzzle flash, fumes, blast, the set-back of the vehicle and the dust thrown up after the gun fires tend to distract the crew and may spoil observation from the tank altogether. The above factors will vary according to conditions.

Muzzle flash is not a serious handicap by day and can be overcome with practice and training. The crew commander and gunner must be trained to blink or to glance down (without moving the head) at the moment of firing, to avoid being temporarily blinded by the flash which lasts considerably less than half a second and look at the target immediately afterwards to observe the effect of the shot. Muzzle blast and the set-back of the vehicle do not affect the gunner as much as the commander. At short and medium ranges up to 1200 yards approximately, (depending on visibility and the nature of the ground), it is often better for the crew commander to observe through the periscope as it is then easier for him to recover his position of observation after the gun fires.

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When using binoculars, the crew commander should hold them firmly on the line of the target by resting his forearms against the cupola ring. As he gives the order to fire, he should withdraw his head slightly from the binoculars, blink or glance down momentarily, and then look through the binoculars to observe the strike. The gunner will shout "Firing now" just before he fires. Dust is the worst handicap to observation. Due regard must, each shot, therefore, be paid to the nature of the ground, direction of the wind and relative position of other tanks. It is essential moreover, to ensure that the muzzle brake is correctly fitted and secured with the gas ports to the sides. If the brake rotates during firing, the amount of dust and debris thrown up will be increased considerably. When it is impossible to observe owing to dust, it may prove expedient for the crew commander to dismount and direct fire by remote control. A remote control lead is being provided for this purpose. He should lie, if possible, on the windward side and slightly forward of the vehicle. On other occasions assistance in observation may be given by other tanks in the troop.

(ii) Ground and target.

It is easier to observe the strike on dry ground than on ground which is wet, soft or covered with long grass or undergrowth where it may be impossible to observe the strike at all if the projectile misses the target.

At short and medium ranges, it is usually possible to assess accurately the relation between strike and target. The gunner must correct from the first point of impact and not be misled by the dust or mud thrown up by the shot.

At long range, however, when the ground is fairly level, the foreshortened view makes it difficult to tell the exact distance of the strike from the target. There is a tendency to underestimate errors and bold corrections are required. When the target is on level ground, a shot which just misses the edge or top of the target will strike the ground a long way beyond the target. If, however, the target is sited against a rising background, it is possible to locate the strike accurately as on a clockface.

(iii) Observation of trace.

AP and HE projectiles are fitted with tracer which is of great assistance in conditions where it is difficult or impossible to observe the strike or burst. The muzzle flash and the short time of flight make the observation of the trace of the 17 pr. projectile difficult at ranges of less than 700 yards. The pale colour of the original type of trace is difficult to see especially in bright light but the improved dark red trace is easier to observe. Commanders and gunners, however, must be trained to recover themselves in the shortest possible time so that however short the range, they will succeed in observing the strike, if necessary with the assistance of the trace. To observe the strike at all, they must watch the TARGET AREA and not attempt to follow the path of the trace through the air. The 17 pr. gun is a high velocity weapon and although the trajectory is comparatively flat up to 1200 yards, at long ranges the culminating point of the trajectory is high. If the gunner tries to follow the path of the trace from muzzle to target, he will obtain a false impression of where the shot is going and will generally think the shot to be plus. He should watch for the trace at the target end and observe its relation to the target. The crew should learn to appreciate the time of flight at various ranges and know when to expect the shot to arrive at the target. The time of flight of 17 pr. APC projectiles at key ranges is as follows :-



<u>Range</u>	<u>Secs.</u>
500 yards.	0.55
1000 yards.	1.14
1500 yards.	1.79
2000 yards.	2.52
2500 yards.	3.35

Trace is of particular assistance when the target is sited on a crest or on level ground at long range. It is then the only means of correcting shots other than those which fall minus. Corrections are made from the appearance of the trace as the shot passes the target.

### Conclusion.

Finally, good observation is the result of eye-alertness, concentration, constant practice and the use of good binoculars and sights, since the clues offered are usually small and momentary but of great importance. It may be difficult to be sure that a tank has been destroyed; a hit is usually indicated by a flash but a target hit is not necessarily a target destroyed.

(d) CORRECTION OF FIRE.

The methods of correcting fire depend upon the range, the nature and position of the target and the ability of the gunner to observe the strike, trace or burst accurately in relation to the target. If the gunner fails to observe or cannot observe accurately, corrections are made by the crew commander. If the gunner fails to observe, he will report "NOT OBSERVED".

LINE OF SIGHT CORRECTIONS.

When it is possible to form an accurate relation between the strike or trace and the line of sight to the target, corrections are made by the line of sight method. Line of sight corrections are applied in several ways according to whether the gunner or crew commander is correcting fire and according to the range.

(i) Clock-face corrections.

When a target is sited against a rising back-ground as on a clockface it is possible for the gunner at short and medium ranges to form an accurate relation between the strike, target and telescope graticule. As soon as the gun is fired, the gunner should, if necessary, relay on the target to ensure that the position of the strike can be located exactly in the sight in relation to the target. For the next round the target should occupy the same place in the sight as the strike of the first round. If the error is small, it will be corrected by moving the gun, i.e. by aiming up or down, right or left. If the error is large, it will be corrected by keeping the gun laid as for the first round and moving the telescope graticule on to the strike or burst by means of the deflection and elevation knobs. The gun will then be relaid and the target re-engaged. The same method is applied by the gunner to correct minus errors at short ranges even when the target is on level ground. For convenience such corrections may be termed "clock-face" corrections.



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FOR LINE EXACT CORRECTIONS WILL BE MADE FROM THE ERROR OBSERVED.

If the target is inconspicuous and the gunner fails to observe the shot, the commander using the graticules in the binoculars will convert errors for line into divisions of the traverse indicator which are equal to 3 minutes. If the commander estimates a shot to strike six minutes left of the target he will order "Right two". The gunner will correct from his original lay. If no traverse indicator is fitted, the deflection scale in the telescope which is marked at intervals of 6 minutes will be used. The commander using binoculars will again convert the line error into units of three minutes. On the order, e.g. "Right two", the gunner will move the vertical crosswire six minutes to the LEFT. He will then relay on the target. After the target has been engaged, the gunner must re-set the vertical wire to zero before engaging another target. The gunner must understand clearly that each interval in the telescope is regarded as 2 divisions and that the commander's order refers to the direction in which the gun is traversed to correct the error and not the direction in which the telescope graticule is deflected.

### ALTERATION OF RANGE.

When an inconspicuous target is being engaged and the gunner fails to observe the shot, the commander will order the gunner to correct for elevation by altering range by a definite amount which will enable the gunner to hit the target. The following corrections expressed in hundreds of yards and divisions of the elevating wheel will be made :-

<u>Range.</u>	<u>Corrections.</u>
Up to 2000 yards	200 yards { or 2 divisions }.
2000 - 2500 yards	400 yards { or 4 divisions }.



(e) DETAILED METHOD OF ENGAGEMENT.

LAYING FOR LINE.

The commander will use the ~~vane~~ sight to direct the gunner in laying for line. In circumstances where it is dangerous to expose the head from the turret, the commander will sight through the periscope. Accurate use of the vane sight is essential especially in directing the gunner on to an inconspicuous target or on to a target which the gunner does not identify at all.

LAYING FOR ELEVATION.

The commander will give the range to the target and indicate the target to the gunner. The gunner will select the graticule in the telescope appropriate to the ammunition at the range concerned and lay it on the centre of the target.

centre of the target.  
If the gunner fails to identify the target as may well happen even at short range, the gunner must fire at the range ordered despite his failure to see the target.

## CORRECTIONS.

If the gunner observes the strike, trace or burst clearly, he must be trained to make corrections himself.

At short and medium range, the commander will assume control only if the gunner fails to observe.

At long range the commander will normally assume control by personal observation and correction of fire, but the gunner must still be trained to make corrections provided he can observe so that targets can be engaged when the commander is pre-occupied with more urgent matters.

At all ranges, when the gunner fails to identify the target the commander must control fire.

The methods of correcting fire are classified according to the following conditions :-

- (i) Range - Short, medium or long.
- (ii) Type of target - conspicuous, inconspicuous or not identified at all.
- (iii) Position of target - on level ground or against a rising background.
- (iv) Whether the gunner or the commander is controlling fire.

C O N T R O L   O F   F I R E			M E T H O D   O F   C O R R E C T I N G	
		BY GUNNER.		BY COMMANDER.
		For errors of line and <u>plus</u> errors of elevation, correct in target size from the trace.		Correct all errors in target size.
		For errors of line and <u>plus</u> errors of elevation, correct in target size from the trace.		
		For minus errors, correct by clock-face method from the strike.		
		For errors by clockface		



# CONTROL OF FIRE

RANGE	TYPE OF TARGET	POSITION OF TARGET.	METHOD OF CORRECTING.	
			BY GUNNER.	BY COMMANDER.
1. SHORT (up to 800 yds)	(a) Conspicuous	(i) On level ground.	For errors of line and <u>plus errors</u> of elevation, correct in target size from the trace.	Correct all errors in target size.
		(ii) Against rising ground	For minus errors, correct by clock-face method from the strike. Correct all errors by clockface method from the strike.	
	(b) Inconspicuous	(i) On level ground	For errors of line and <u>plus errors</u> of elevation, correct direct from appearance of trace according to the amount of the error observed.  For minus errors, correct from strike by clock-face method.	Correct for line in divisions of traverse indicator or in divisions of deflection scale in telescope. Correct for elevation in hundreds of yards, e.g. "Up 200" or in divisions of elevating wheel, e.g. "Up 2".
		(ii) Against rising ground.	Correct all errors by clockface method from the strike.	
2. MEDIUM (800 to 1500 yards)	(a) Conspicuous	(i) On level ground	For errors of line and <u>plus errors</u> of elevation, as above at SHORT range.  For minus errors, correct in target size.	As at SHORT range.
		(ii) Against rising ground.	As at SHORT range.	As at SHORT range.
	(b) Inconspicuous	(i) On level ground	As at SHORT range	As at SHORT range.
		(ii) Against rising background	As at SHORT range.	As at SHORT range.



(Cont.)

RANGE	TYPE OF TARGET	POSITION OF TARGET	METHOD OF CORRECTING.	
			BY GUNNER	BY COMMANDER
3. LONG (1500 to 2500 yards).	(a) Conspicuous	(i) On level ground	<u>Errors of line.</u> Correct in target width.	As for gunner at LONG range.
			<u>Errors of elevation.</u> Double the error observed in target height.	
		(ii) Against rising background .	As above.	As above.
	(b) Inconspicuous	(i) On level ground	<u>For errors of line, correct according to the amount of the error observed.</u>  <u>For errors of elevation, alter range by 200 or 400 yards (according to the range)</u>	Correct for line in divisions of traverse indicator or in divisions of deflection scale in telescope.  Correct for elevation by 200 or 400 yards (according to the range) or by 2 or 4 divisions of the elevating wheel.
(ii) Against a rising background		As above.		



### 2. APDS.

#### (a) USE.

The use of APDS ammunition despite its excellent qualities of penetration is limited by its doubtful accuracy beyond certain ranges and its short supply.

If a target can be penetrated by APCBC, the crew commander should order APCBC (in view of its greater accuracy and better supply) in preference to APDS. If a target is however vulnerable to APDS only, the decision to use APDS will be governed by the need for accuracy. A small target such as a hull-down tank may be engaged at ranges up to 400-500 yards but a target in full view may be engaged at slightly longer ranges. As a general rule, 800 yards should be regarded as the maximum range of the present APDS Mk. 1B ammunition.

#### (b) LAYING.

The telescope is NOT marked with a range scale for APDS ammunition. The following ranging rule will be used :-

Set the graticule to half the range on the APCBC scale for engaging targets at ranges not exceeding 800 yards.

The point of aim will be the CENTRE of the target.

#### (c) OBSERVATION AND CORRECTION.

Owing to the high muzzle velocity and smallness of the projectile, the strike of shot is difficult to observe if the target is not hit. Moreover it has been proved by experience that it is not normally possible for the crew within the tank to observe the trace at normal fighting ranges but that an observer outside the tank may do so. Again even if the shot is observed, the gunner should not attempt to correct from round to round.

#### (d) DANGER ZONES.

The following considerations should be borne in mind when it is intended to fire APDS within close proximity of one's own troops.

- (i) The maximum range of the sabot is about 250 yards, with a spread of approximately 6 degrees measured from the gun muzzle. The pieces of sabot are lethal except at extreme range.
- (ii) The base plate strikes at about 600 yards with a remaining velocity of 1000-1500 ft/sec. The base plate is lethal for some distance beyond the strike.

### 3. HE SHOOTING (full charge/beyond AP ranges and reduced charge).

HE may be fired by direct, semi-indirect or indirect means. See AFVP/MSG/58 for Indirect fire.

#### (a) THEORY OF ELEVATION.

For direct shooting, elevation is calculated from the line of sight and is known as tangent elevation. For semi-indirect or indirect shooting, elevation is calculated from the horizontal plane and is known as quadrant elevation. Quadrant elevation differs from tangent elevation by the angle of sight.

$$Q.E. = T.E. + \text{Angle of sight.}$$



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If the target is above the horizontal plane, the angle of sight is positive and must be added to the tangent elevation. If it is below the horizontal plane, the angle of sight is negative and must be subtracted from the tangent elevation. If the tank and target are not on the same level, the angle of sight must be taken if time allows. The more accurately the angle of sight is measured, the nearer the first round will be to the target.

(b) LAYING FOR LINE.

DIRECT FIRE (i.e. target visible to gunner and commander).

The commander will use the vane sight to direct the gunner in laying for line.

SEMI-INDIRECT FIRE (i.e. target visible to commander ONLY).

If the tank is turret-down, the commander will not be able to align the vane sight on to the target because his line of sight will meet the crest but he can extend it fairly accurately over the crest to the target.

He may also align the vane sight on to a prominent object which is on the same line as the target. Allowance for drift (contained in range tables) should be made at long range.

If no traverse indicator is fitted, the gunner must pick out a definite aiming mark in the foreground when he has laid for line. This mark is used as the reference from which corrections for line can be made by means of the deflection scale in the telescope.

(c) LAYING FOR ELEVATION.

DIRECT FIRE.

(i) If the target is within range of the telescope, the gun will be set at the required elevation by laying the appropriate graticule on the target.

(ii) If the target is outside the range of the telescope, the gunner will lay for elevation by one of the following methods :-

1. Set the graticule to ZERO and lay it on the target (to allow for the angle of sight).  
Elevate in turns and divisions of the elevating wheel.
2. Set the range drum and telescope graticule to zero.  
Lay the telescope on the target (to allow for the angle of sight) and bring the bubble in the sight clinometer central by turning the micrometer head.  
Set the range drum to the required range and elevate the gun until the bubble is central.

INDIRECT FIRE.  
If AFV sight gear is fitted  
1. Set clinometer to zero  
2. Set the range drum to  
3. Elevate the gun until  
If AFV sight gear is NOT  
1. Set clinometer to zero  
2. Elevate the gun by the

DEFINITION.

Bracketing is the process of firing so that fire may be opened

LINE.

It is comparatively easy shooting. In direct shooting similar to that described for indirect, the commander measures the distance of correction to the gunner's traverse indicator is for line in the foreground for line calculated from scale of the telescope

ELEVATION.

Beyond certain ranges and the foreshortened exactly the error of zone of dispersion of position of the m.p. For these reasons, normally carried out bracket, until sufficient

BRACKETING.

Corrections for ranges :-

(i) The long

When a range make a correction bracket



## SEMI-INDIRECT FIRE.

(i) If AFV sight gear is fitted.

1. Set clinometer to zero (or to the angle of sight if ordered).
2. Set the range drum to the range ordered.
3. Elevate the gun until the bubble is level.

(ii) If AFV sight gear is NOT fitted.

1. Set clinometer to zero (or to the angle of sight if ordered).
2. Elevate the gun by the number of turns and divisions ordered.

(a) RANGING.

## DEFINITION.

Ranging is the process of determining the line and elevation to the target so that fire may be opened for effect.

## LINE.

It is comparatively easy to determine line in direct and semi-indirect shooting. In direct shooting, the method of correcting for line is similar to that described above for AP shooting. In semi-indirect shooting, the commander will use the graticules in the binoculars to measure the distance of the burst from the target and will pass the correction to the gunner in divisions of the traverse indicator. If no traverse indicator is fitted, the gunner will pick out a definite aiming mark in the foreground when he has laid initially for line. Corrections for line calculated from this mark will then be made on the deflection scale of the telescope.

## ELEVATION.

Beyond certain ranges depending on the muzzle velocity of the projectile, and the foreshortened view of the ground, it is impossible to determine exactly the error of elevation of any one round. Moreover, owing to the zone of dispersion of the gun, one round may not indicate exactly the position of the m.p.i. of a group of rounds fired at a certain elevation. For these reasons, beyond certain ranges, ranging with HE ammunition is normally carried out by bracketing the target and breaking down the bracket, until sufficiently accurate information is obtained.

## BRACKETING.

Corrections for range are made by bracketing usually at the following ranges :-

HE full charge	-	2500 yards and over.
HE reduced charge	-	1000 yards and over.

(i) The long bracket.

When a round is observed to be plus or minus, the crew commander will make a correction to bracket the target with the next round. This correction known as the long bracket is a multiple of the short bracket and is usually from one-eighth to one-quarter of the range.



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(ii) The short bracket.

The short bracket consists of a pair of elevations which differ by approximately twice the 50 per cent zone of the gun at the range concerned. Ranging is normally continued to a short bracket unless definite information is received previously, i.e. from a direct hit. If ranging has been continued to a short bracket, the bracket should be halved before opening fire for effect.

(iii) Zones of dispersion.

If a succession of rounds is fired from a gun laid each time at the same line and elevation, they will not all fall on the same spot, owing to minor differences in manufacture from round to round, or variation in jump, wind and atmospheric conditions. The rounds will, however, tend to group themselves more or less symmetrically with reference to a central point which is known as the "mean point of impact" (m.p.i.).

The dispersion of the shells is illustrated diagrammatically in a rectangle to illustrate the percentage zones. Thus, if the 100 per cent length zone is divided into eight parts the 50 per cent zone is contained in the two central rectangles.

For effective shooting against a small target, the m.p.i. should coincide with the target. In practice, however, such accuracy may only be attained with considerable expenditure of ammunition.

(iv) Table of long and short brackets.

Range Yards	HE Reduced Charge				HE Full Charge			
	Brackets (Yards)		Brackets (Hand-wheel Divs.)		Brackets (Yards)		Brackets (Handwheel Divs.)	
	Short	Long	Short	Long	Short	Long	Short	Long
1500	50	200	1	4	100	200	1	2
2000	50	200	1	4	100	200	1	2
2500	50	400	1	8	100	400	1	4
3000	50	400	1	1 turn	100	400	1	4
3500	50	800	2	1 turn	100	800	1	8
4000	50	800	2	2 turns	100	800	2	1 turn
4500	50	800	2	2 turns	100	800	2	1 turn
5000	50	800	2	2 turns	100	800	2	1 turn
6000	50	800	4	2 turns	100	800	4	1 turn

Note :- Corrections for range may be made on the range drum or in handwheel divisions.

When the sight clinometer is provided with a faster bubble (with its greater degree of accuracy), the range drum will normally be used.

THE RULES OF OBSERVATION  
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(2) ENGAGEMENT OF T

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## (e) BASIC RULES OF OBSERVATION AND CORRECTION.

- (i) A shell is plus if the burst is seen behind the target.
- (ii) A shell is minus if the target is hidden by the burst.
- (iii) Careful and quick observation of shells falling just plus or minus or left or right is necessary as smoke and dust tend to envelop the target and so confuse the commander.
- (iv) It is better that the first round is minus of the target rather than plus unless there is dead ground minus of the target.
- (v) If the first round is unobserved, the crew commander should correct either for line or elevation in an attempt to obtain observation. The nature of the correction will depend on the configuration of the ground.
- (vi) When the position of the burst in relation to the target is known, correction for line must be made before correction for range.
- (vii) If the first round is out for line and only slightly out for range, then correct for line only, as it is impossible to tell whether the round is plus or minus.
- (viii) If the first round is very much wrong for line and range, first correct accurately for line with binoculars and then boldly for range. Make the dual correction in that order. If the commander's error in estimating range is very large, it is better to re-range. If the first round is out for line, then correct for line when re-ranging.

## (f) FIRE FOR EFFECT.

When clear and definite information is received either from a bracket or from a single round, fire is opened for effect. In practice, it is impossible to distinguish clearly between ranging and fire for effect. A single tank firing direct may fire for effect with the second round.

If, during fire for effect, the majority of rounds are seen to fall plus or to fall minus, it will be necessary to adjust the m.p.i. on to the target by quartering the short bracket.

Fire for effect may be applied as follows :-

## (i) Troop fire.

In a collective shoot, the guns normally fire in succession from the right, a specified number of rounds at a pre-determined interval.

Note :- It may be necessary to fire from the left in certain wind conditions.

## (ii) Gunfire.

In a collective shoot, the guns fire a specified number of rounds (usually three), independently as soon as they are ordered. The commander must observe gunfire carefully to adjust the m.p.i. if necessary.

## (g) ENGAGEMENT OF TARGETS.

Targets will normally be engaged by single AFVs and not by a troop. It is good policy to allow one tank in the unit to fire first so that the information obtained may be passed to other commanders to save ammunition during ranging. A target such as a well-hidden and strongly defended position of anti-tank guns may be engaged with the concentrated fire of a troop, troops or even a squadron. The squadron commander is responsible for the fire discipline of the squadron.

HE Full Charge			
Brackets (Yards)		Brackets (Handwheel Divs.)	
Short	Long	Short	Long
00	200	1	2
00	200	1	2
00	400	1	4
00	400	1	4
00	800	1	8
00	800	2	1 turn
00	800	2	1 turn
00	800	2	1 turn
00	800	4	1 turn

on the range drum or in  
ded with a faster bubble  
cy), the range drum will



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(h) SEMI-INDIRECT(TURRET-DOWN) SHOOTING.

POSITION OF THE VEHICLE

Advantage can sometimes be taken of turret down positions for HE shooting. It is essential that crews are trained in taking up turret down positions and, therefore, during training, tanks will always move up into the correct position before firing. At first, it may be necessary to halt the vehicle several times before reaching the correct position, but with practice, it may be done without halting. Commanders will manoeuvre their tanks to get the trunnions as level as possible when the gun is pointing in the target area. If the trunnions are canted, i.e. not on the same level, the elevation of the gun will be altered when the turret is traversed, and line will be altered when the gun is elevated or depressed.

CREST CLEARANCE.

When the tank is turret-down, it is essential to ensure that the round will clear the crest. The term "crest" includes any mask or cover such as hedges, trees, buildings as well as the ground itself. It is usually sufficient in a turret-down shoot when the crest is normally close to the guns to check crest clearance by looking through the bore of the gun and elevating until the gun clears the crest. In checking crest clearance, the loader will look in a line from the top of the chamber to the bottom of the muzzle. If, in setting the initial range, the gunner has to depress the gun with consequent danger of fouling the crest, the tank must be moved to a position from which the target can be engaged. The loader will check crest clearance after each "down" correction until a bracket is obtained. The commander will give the order "Check crest clearance" after such "down" corrections.

METHOD OF ENGAGEMENT

Targets may be engaged by single tanks or collectively as a troop.

RESPONSIBILITY OF CREW.

- (i) The crew commander is responsible for controlling the fire of his tank during individual engagements. He is responsible for observing and correcting fire during a collective shoot.
- (ii) The gunner is responsible for maintaining line during fire and if no traverse indicator is fitted must pick out an aiming mark on which his telescope is laid so that corrections for line may be made on the deflection scale of the telescope.
- (iii) The loaders are responsible for crest clearance.

TROOP HE SHOOT.

- (i) Fire discipline.  
The Troop leader is responsible for the fire discipline of his troop but his control will NOT deprive individual crew commanders of the responsibility for observing and correcting the fire of their own tanks.
- (ii) Position of vehicles.  
The Troop leader manoeuvres the troop into a suitable position to engage the enemy. He may place himself in the centre of his troop but it is not good policy for him to occupy at all times the same position in the troop. The intervals between vehicles are normally 50 to 80 yards but they should be regarded as reasonably flexible depending on the use of ground and cover.

Procedure.  
1. One tank in the troop leader's position.  
2. When the Troop leader carefully for the fall of their guns on to it (fitted) or as a clinch.  
3. Without further order round to be fired reasonably correct target area for elevation. Corrections will be sufficient for reg crew commanders.  
4. When the target is hand as a signal or to wait.  
5. If he decides to "gunfire". Crew cutting down his  
6. If he decides by .... minute of the allotted  
7. At the end of and if necessary  
8. After a target should be not become active

MACHINE-GUN SHOOTING.

(a) THE WEAPON.

The machine-gun, which is a man-killing weapon.

(b) CHARACTERISTICS.

The chief characteristics of its high muzzle velocity gives the bullet therefore, influence appreciated by individual bullet form a pattern height and width (.30" Browning) yards and 30 ft known as the range increase. The



(iii) Procedure.

1. One tank in the troop will range on to the target. (It is assumed here that the Troop leader is ranging).
2. When the Troop leader begins to range, all other commanders watch carefully for the fall of shot to spot the target and traverse their guns on to it for line.
3. When ranging is complete, the Troop leader will pass to the other tanks the final elevation in yards (if the AFV sight gear is fitted) or as a clinometer reading (if the AFV sight gear is NOT fitted).
4. Without further orders, the other crew commanders will order one round to be fired at the elevation ordered. This round should be reasonably correct for line and should be in or close to the target area for elevation.  
Corrections will be made DIRECT. Normally two rounds should be sufficient for registration but more may be required by inexperienced crew commanders. The Troop leader must observe the fire of the other tanks, especially if the crew commanders are inexperienced, to assist if necessary in observation and correction of fire.
5. When the target has been registered, each commander will raise one hand as a signal to the Troop leader that **he is** ready.
6. The Troop leader will decide whether to fire for effect immediately or to wait.
7. If he decides to fire immediately he will order "Three rounds gunfire". Crew commanders will report ready by raising one hand. The Troop leader will give the order to fire by raising and cutting down his arm.
8. If he decides to wait, he will order "Three rounds gunfire. Stand by .... minutes". He will give by hand the order to fire at the end of the allotted time.
9. At the end of three rounds gunfire, the Troop leader will observe and if necessary correct all tanks and order a further concentration.
10. After a target has been engaged, the line and elevation to it should be noted so that it may be re-engaged later if it should become active again or if movement is seen.

4. MACHINE-GUN SHOOTING.(a) THE WEAPON.

The machine-gun, when used under suitable conditions, is the most effective man-killing weapon in the tank.

(b) CHARACTERISTICS.

The chief characteristics of the machine-gun are its quick rate of fire, its high muzzle velocity and dispersion of shots. The high muzzle velocity gives the bullets a flat trajectory up to 700 yards (approximately) and will, therefore, influence methods of fire. The dispersion of shots must be appreciated by every gunner for the correct application of fire. The individual bullets fired from a machine gun do not follow the same path, but form a pattern in the air known as the cone of fire, which increases in height and width with the range. For example, the height of the 100% (.30" Browning ball ammunition) zone is 8 ft. at 500 yards, 15 ft. at 1000 yards and 30 ft. at 1500 yards. The pattern of shots on the ground is known as the beaten zone. The length of the beaten zone decreases as the range increases up to 2000 yards. Over 2000 yards, the length begins to increase. The width of the beaten zone increases up to extreme range.



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Range. (Yds)	Effective 90% Beaten zone (length x breadth in yards).	
500	186.4	x 1.2
1000	110.9	x 2.4
1500	79.2	x 3.7
2000	68.2	x 4.9
2500	90.2	x 6.1
3000	134.0	x 7.3

All crew commanders should know roughly the length of the beaten zone at the above key ranges. It is noticeable that the beaten zone is very narrow in comparison with its length. From these characteristics it may be inferred that it is essential to be correct for line on account of the narrowness of the beaten zone and that the length of the beaten zone makes enfilade fire very effective (i.e. when fire is laid down the length of the target).

### (c) TYPES OF FIRE.

#### DIRECT FIRE.

The normal method of engaging targets will be by direct fire. Its main asset is the extreme flexibility which enables a succession of targets over a wide arc to be engaged quickly. Targets may be engaged by direct fire from a stationary vehicle at ranges up to 1500 yards or more depending upon observation or from a moving vehicle at ranges up to 800 yards.

#### SEMI-INDIRECT FIRE.

It is often useful for tanks to engage suitable targets with the machine gun instead of HE from turret down positions. The minimum range at which the machine gun can be fired semi-indirect is governed by the need for crest clearance. The maximum range is governed by observation.

#### INDIRECT FIRE.

The principles and methods of indirect fire described in AFVP/MSG/58 may be applied to the machine-gun.

### (d) OBSERVATION.

The object of observation is to deduce from the strike of the bullets the position of the beaten zone with reference to the target. The possibility of observing the strike will depend on a number of factors of which the following are the most important :-

- (i) The distance of the observer from the target.
- (ii) The nature of the soil around the target. Dry ground, sand, plough and water generally give good results but damp ground, long grass and undergrowth are bad.
- (iii) Visibility as affected by light, mist or mirage.
- (iv) The position of the sun. It is easier to observe the strike when the sun is low than when it is high.
- (v) Wind. A high wind tends to blow away the dust caused by the strike before it can be observed.

In battle, the fall of shell and strike of bullets from other machine-guns may interfere with accurate observation. Since the purpose of observation is to know the position of the beaten zone in relation to the target, it is essential to decide whether the whole beaten zone is being observed or only a small portion of it. The whole area in which the beaten zone is to fall should be observed rather than the ground in the immediate vicinity of the target. If an area of ground adjacent to the target is specially suitable for observation, it may be profitable to direct

on to this area  
as observation has  
to 800 yards.  
the crew must NOT be misl  
able the beaten zone on th  
the target.  
the beaten zone to

LENGTH OF BURST.  
At short ranges (up to  
sufficient to afford an  
assessing the accuracy  
difficult and a longer  
bursts for medium rang  
while for long ranges  
generally be sufficien  
burst employed will de  
where the target is a  
transport or a large  
fire distributed over  
where the target is  
the bursts of fire s  
occupies the centre

### (e) POSITION OF BEATEN

- (i) If the target  
of fire, the  
should coincid  
it may be be  
the beaten  
the cone at  
engaged, th  
of the tar
- (ii) If the tar  
centre of

### (f) CORRECTIONS.

- (i) Line.

The trac  
target i  
of the s  
command  
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- (ii) Elevati

At ran  
himself  
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target  
(e.g.  
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ini



fire on to this area at first and then correct on to the target as soon as observation has been obtained. The tracer ammunition gives a good indication of line and elevation at ranges up to 800 yards. The crew must NOT be misled by the trace at longer ranges but must watch for the beaten zone on the ground. Bursts of fire must be long enough to enable the beaten zone to be found as well as to produce the required effect on the target.

#### (e) LENGTH OF BURST.

At short ranges (up to 800 yards) a burst of 10-15 rounds is generally sufficient to afford an opportunity of locating the beaten zone and assessing the accuracy of fire. At the longer ranges observation is more difficult and a longer burst of fire is needed. The suggested length of bursts for medium ranges (800 - 1500 yards) is 15-25 rounds approximately, while for long ranges (1500 yards and over) a 25-30 rounds burst will generally be sufficient. Once the beaten zone registers, the length of burst employed will depend upon the size of the target.

Where the target is a large one, such as a trench system, column of transport or a large body of men, bursts of fire should be short and the fire distributed over the target area. machine gun

Where the target is a small one, such as a / or a small body of men, the bursts of fire should be longer and the fire so placed that the target occupies the centre of the beaten zone.

#### (f) POSITION OF BEATEN ZONE.

The position of the beaten zone will vary according to the type of target :-

- (i) If the target is upstanding and its height is greater than the cone of fire, the beaten zone should be plus while the centre of the cone should coincide with the centre of the target. In practice, however, it may be better to obtain a few minus observations to ensure that the beaten zone is not too much plus. For example, the height of the cone at 500 yards is 8 ft. If a truck 10 ft. high is being engaged, the cone of fire should, if possible, pass through the centre of the target.
- (ii) If the target is smaller than the cone of fire, it should be in the centre of the beaten zone.

#### (g) CORRECTIONS.

##### (i) Line.

The tracer ammunition gives a good indication of line. When the target is visible to the gunner, he must correct direct from observation of the strike. When the target is NOT visible to the gunner, the commander, using binoculars, will correct the gunner in divisions of the traverse indicator (if fitted).

##### (ii) Elevation.

At ranges up to 1,000 yards (depending upon visibility) the gunner himself will correct direct on to the target. The commander must intervene if the gunner fails to assess the error accurately. If the target is well-defined, the commander will correct in target height (e.g. "Up  $\frac{1}{2}$  target height"). If the target is not well-defined, corrections will be given in hundreds of yards (e.g. "Up 100"). At ranges over 1,000 yards, it is not usually possible to determine the exact amount by which the beaten zone is falling over or short of the target. Some form of bracketing is, therefore, required to prevent creeping towards the target with inadequate corrections. The following initial corrections are suggested :-

Range	Corrections.
1,000 - 1,500	200 yards or 4 divisions.
1,500 - 2,000	400 yards or 12 divisions.

The commander will observe the fire and correct further, if necessary, by halving the bracket.



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SECTION 12 - SHOOTING AGAINST MOVING TARGETS.

1. GENERAL.

AP fire against moving targets is normally limited during training to 1000-1200 yards, but in battle the range at which fire is opened is governed by the need for penetration. It is not recommended that APDS ammunition be fired against moving targets. Soft-skinned targets can be engaged by direct HE and MG fire up to the limit of the gunner's vision.

2. DIRECTION OF AIM-OFF.

The direction of aim-off will be determined by the direction in which the target is moving. The gunner must note the direction of traverse necessary to keep on the target, and aim-off in the same direction. The commander will assist the gunner by ordering the direction of aim-off and will, if necessary, state his observation of fire.

Rule 1.

If traversing LEFT, aim LEFT.  
If traversing RIGHT, aim RIGHT.

3. AMOUNT OF AIM-OFF.

Since it is impracticable to gauge the speed of the target, it is essential that the gunner is provided with a simple rule of aim-off, which will give him a reasonable chance of hitting the target with the first shot at all effective ranges and at different target speeds. It has been calculated that, by laying the outer edge of the first horizontal graticule on the CENTRE of the target, hits will be obtained with APCBC ammunition on a broadside target 20 feet long at the following speeds and ranges:-

<u>Range (Yards)</u>	<u>Speed (m.p.h)</u>
500	0 - 22
1000	3 - 16
1500	5 - 13
2000	6 - 11
2500	6 - 10
3000	6 - 9

The above aim-off measures  $17\frac{1}{2}$  minutes. (See Figure 14).

Rule 2.

For the first shot, lay the outer edge of the first horizontal graticule on the centre of the target.

4. METHOD OF AIMING-OFF.

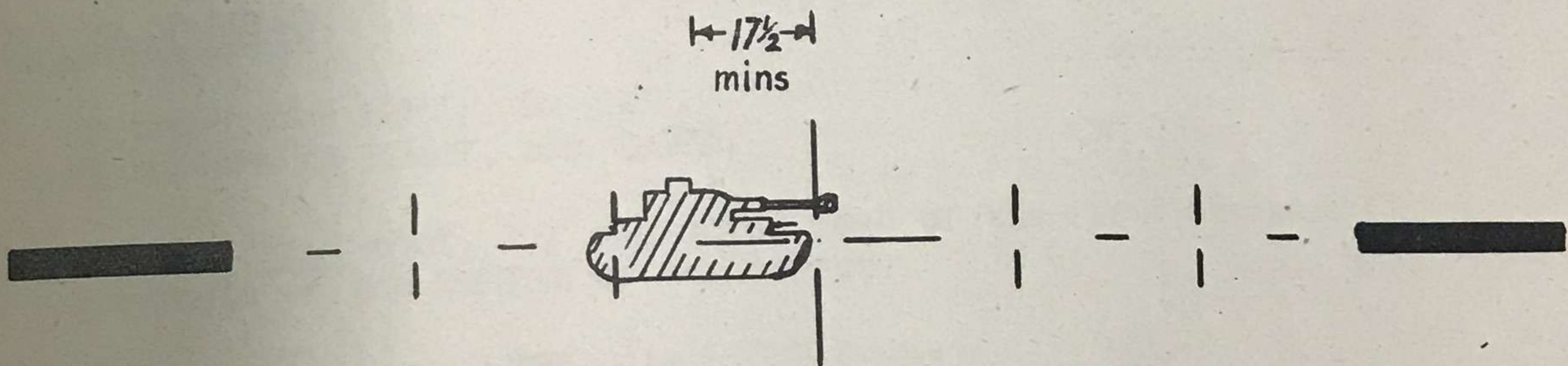
There are two methods of aiming at a moving target. The first method is to track the target with the correct aim-off. The other method is to lay ahead of the target and fire when aim-off is correct. If the gunner lays ahead, he must make some allowance for the movement of the target during the firing interval. Speed is more than ever vital in engaging moving targets. The higher the rate of fire consistent with good laying, the less alteration of aim is required.

TELES

AFVP/D/851.



# AIM - OFF TELESCOPE **No 43, x3, M.L. Mk.3**



Amount of Aim-off - 17 1/2 mins.

**FIG. 14.**

AFVP/D/851.

is normally limited during training to the range at which fire is opened. Ammunition be fired against moving targets by direct HE and MG fire up to 1000 yards. It is determined by the direction in which the target is moving. Note the direction of travel and aim-off in the same direction. By ordering the direction of fire, the observation of fire.

speed of the target, it is with a simple rule of aim-off, setting the target with the first percent target speeds. It outer edge of the first target, hits will be obtained 20 feet long at the

## Speed (m.p.h)

- 0 - 22
- 3 - 16
- 5 - 13
- 6 - 11
- 6 - 10
- 6 - 9

Figure 14).

the first horizontal

t. The first method  
The other method  
is correct. If the  
movement of the  
targets. The higher  
alteration of



5. CORRECTIONS.

Although the aim-off suggested above covers a wide range of target speeds, the gunner must observe the effect of his fire and correct if necessary. He must also observe carefully the re-action of the enemy when fired upon and allow for any change in speed or direction of the target.

For practical purposes, it is best that the gunner applies an automatic correction according to the error observed. If the shot misses right, the gunner will lay on the left edge of the target for the next. If the shot misses left, he will lay on the right edge.

Rule 3

If the shot misses LEFT, aim RIGHT edge.

If the shot misses RIGHT, aim LEFT edge.

In practice, it will be found that provided the gunner is conversant with the foregoing rules, aim-off is NOT difficult. Errors of elevation will be more frequent than errors of line. It is essential that allowance is made for alteration of range when a target is moving obliquely to the line of sight or changing elevation. It is necessary even to aim-off for range. Such allowance can only be made after careful observation and correction of fire.

6. SUMMARY OF RULES.

1. If traversing LEFT, aim LEFT.  
If traversing RIGHT, aim RIGHT.
2. For the first shot, lay the outer edge of the first horizontal graticule on the CENTRE of the target.
3. If the shot misses LEFT, aim RIGHT edge.  
If the shot misses RIGHT, aim LEFT edge.



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SECTION 13 - SHOOTING ON THE MOVE.

1. ITS IMPORTANCE.

Although the accuracy of fire from a moving vehicle can never be equal to that from a stationary vehicle, it will nevertheless, be necessary to fire on the move during the final assault or in a surprise encounter during movement. Training in firing MG and HE on the move ranks second in importance to direct fire from a stationary vehicle and the practice so gained should enable the gunner to fire AP fairly accurately on the move when necessary.

2. RESPONSIBILITY.

The volume and accuracy of fire will be directly affected by the nature of the ground over which the tank is moving, by the rate of movement and by the driver's control of the tank.

The driver should think of the tank as a gun platform and should, as far as enemy action allows, look ahead and shape a course over the best going he can find. The tank should be driven at a uniform speed and any changes of speed or direction made gradually. Jerky use of the accelerator, steering controls and gear changing mechanism will disturb the gunner. The driver, on hearing a fire order given to the gunner should adjust the tank speed and refrain from steering unnecessarily during firing. However well the driver responds to the needs of the gunner, it is essential that the gunner is trained to acquire "tank sense" which is the ability to anticipate the movements of the gun platform. The different sounds of the engine and transmission can be associated with different types of going and by appreciating this, the gunner is able to seize the most opportune moment for firing. Full advantage must be taken of periods of minor oscillation.

3. MANIPULATION OF CONTROLS.

The length of time during which the gun will be laid on the target will depend on the gunner's use of the controls and anticipation of the movements of the tank. The sight will move either laterally or vertically but with practice the sight can be held on the target with considerable success. On other occasions, the gunner will have to time the firing of the weapon with the movement of the sight on to the target and must allow for firing interval.

4. OBSERVATION AND CORRECTION.

Observation of fire will present more difficulty than at the halt as the sight will probably have moved off by the time the shell or bullets have reached the target area. The gunner should be quick to notice whether any error is due to movement of the sight or error in estimating range. During firing on the move, the commander, owing to the urgency of the situation, is usually too much occupied to assist the gunner in correcting fire. If the opportunity occurs, however, as for example in engaging single targets or small areas, the commander may control fire by stating whether the strike or burst is plus or minus or effective. The gunner will know whether the error is due to wrong estimation of range or firing at the wrong moment. When firing head-on or tail-on, allowance must be made for alteration of range.

5. TYPES OF FIRE ON THE MOVE.

(a) M.G.

The machine-gun will be fired on the move at ranges up to 800 yards (approximately). The length of burst will depend on the gunner's ability to keep the target within the beaten zone and will not normally exceed 10 - 15 rounds. The gunner himself will observe and correct fire.

(b) HE.  
The range at  
1000 yards.  
target. Any  
steady platf  
manipulation

(c) AP.  
The techniq  
required in  
ranges ove

6. AIM-OFF.  
For firing on  
the centre of  
graticule on  
same directio



## (b) HE.

The range at which HE is fired on the move will not, as a rule, exceed 1000 yards. The gunner must fire as soon as the sight is laid on the target. Any tendency on the part of the gunner to wait for a perfectly steady platform must be checked. Opportunism, decisive action and good manipulation of the controls are required for successful shooting.

## (c) AP.

The technique of firing AP on the move on the rare occasions when it is required is similar to that of HE. AP should NOT be fired on the move at ranges over 600 yards.

6. AIM-OFF.

For firing on the move, an initial aim-off of  $17\frac{1}{2}$  minutes will be made from the centre of the target, i.e. lay outer edge of the first horizontal graticule on the centre of the target. If tank and target are moving in the same direction and at the same speed, no aim-off is required.



SECTION 14 - SHOOTING AT FIRST AND LAST LIGHT

1. GENERAL.

See AFVP/MSO/17 - "How to use your eyes in the dark" - for the principles of night vision applicable particularly to tank crews. It is re-emphasised here that crews must be trained to fire especially at first and last light to obtain an advantage over the enemy at these critical periods of light. In addition it may be possible, in suitable conditions of moonlight to fire accurately.

2. USE OF BINOCULARS.

High power binoculars, such as the prismatic binoculars No. 5 are particularly efficient in conditions of failing light and have four or five times the range of the naked eye. They also allow the crew to engage targets earlier at the beginning of the day and later at night than the naked eye. For details of focusing and setting binoculars, see AFVP/MSO/17, page 14.

3. USE OF ILLUMINATED GRATICULES.

The purpose of providing illumination for telescope graticules is to allow the gunner to see the graticule. It is essential to appreciate that such illumination will tend to obscure the target. The graticule should, therefore, NOT be illuminated unless it cannot be seen and then the light must be kept as dim as possible so that the graticule is barely visible.

4. MAXIMUM RANGE

The maximum range at which targets will be visible will NOT normally exceed 600-800 yards but targets will generally be engaged at shorter ranges.

5. FIRE CONTROL

The commander will normally control fire owing to the advantage gained from using prismatic binoculars No. 5. A bracket with browpad has been devised for supporting the binoculars which may assist the commander in laying for line. Otherwise the commander will direct the gunner for line by looking along the barrel of the gun. Errors of line are, therefore, to be expected. For elevation, the gun is laid by semi-indirect technique if the target is NOT seen by the gunner. The machine gun may be used effectively for ranging since the tracer allows corrections to be made for line and range by slightly illuminating the target while at the same time the gunner is not disturbed by dust or flash which might accompany the firing of HE and AP. After ranging with the M.G. the flash from HE often provides sufficient light for fine corrections to be made.

SECRET  
Example 1  
(a) INITIAL ORDER  
"Driver right  
17-pr shot  
Traverse 1  
Eight hun  
Panther  
Fire"  
(b) CORRE  
(i)  
(i)  
2. HE  
(a)



SECTION 15 - FIRE DISCIPLINE.

1. AP

Example 1

(a) INITIAL ORDERS

"Driver right ... O.K... halt

Orders to driver.

17-pr shot (or sabot)

The loader will load with the ammunition indicated.

Traverse left ... steady ... On

Laying for line with the aid of the vane sight.

Eight hundred

Range expressed in hundreds of yards. Exact multiples of a hundred or a thousand are expressed thus:- "Four hundred" (400) "Four thousand" (4000).

Panther (Tiger, etc).

Name of target. The target must be identified since the decision to open fire often depends on identification of target.

Fire".

The gunner will shout "Firing Now" just before each round.

(b) CORRECTIONS

(i) Conspicuous targets

"Left  $\frac{1}{2}$  target

All corrections are estimated from the CENTRE of the target.

Up  $\frac{1}{2}$  target

Go on".

(ii) Inconspicuous targets

"Left two

Corrections for line given in divisions of traverse indicator or telescope deflection scale. Correction for elevation given in hundreds of yards or in divisions of the elevating wheel.

Up two hundred (or up two)

Go on".

2. HE

(a) DIRECT FIRE

TARGET WITHIN RANGE OF TELESCOPE

Example 2

"Driver ..... halt.

17-pr shell action.

Traverse right... steady ... On.

Two five hundred.

Transport.

Fire".



TARGET OUTSIDE RANGE OF TELESCOPE.

Example 3

"Driver left... O.K... halt  
17-pr shell action  
Traverse left etc.  
Three eight hundred  
Transport.  
Zero sight.

Range to target.

Level bubble

Set three  
eight hundred  
Fire".

The gunner will set range drum and telescope to zero, lay the telescope on the target to take the angle of sight and shout "On".  
The gunner will elevate the gun until the bubble in the clinometer is central.  
He will set the range drum to the required range and elevate the gun until the bubble is level.  
Note: If the gunner fails to observe the target, the commander may ignore the angle of sight, cancel the order "Zero sight" and use semi-indirect procedure.

Correction.

"Left two

Down eight  
hundred  
Fire".

"Up four hundred  
Fire"

Correction for line in divisions of the traverse indicator or telescope deflection scale.

Initial correction in terms of the long bracket.

Ranging is continued by bracketing, i.e. "Down two hundred, up one hundred" etc. until a short bracket is established.

(b) SEMI-INDIRECT FIRE (turret down)

Example 4.

(i) Initial orders.

Stand by ... turret down  
... shell.

Driver right... O.K...  
slow down... halt

Traverse left.... steady  
... on.

Zero clino

Four five hundred.

Warning to the crew, especially to the loaders, to have ready a supply of HE. They will NOT load until ordered.  
Orders to the driver to manoeuvre the vehicle into the correct turret down position.  
Laying for line.

If no traverse indicator is fitted the gunner must note an aiming mark in the foreground from which accurate corrections for line can be made.  
The gunner will set the sight clinometer to zero (if the angle of sight has NOT been taken) and set the AFV sight gear to the correct range.  
Range to target.



Check crest clearance.

The loader will check the crest, report "Crest clear" or "Crest fouled" and await further orders.

Load and fire".

(ii) Correction.

"Down eight hundred  
Check crest clearance.

The loader will check the crest after the gun is laid and report accordingly.

Load and fire".

3. M.G.

(a) DIRECT FIRE.

Example 5.

(i) Initial orders.

"Driver halt" or  
"Driver advance ten  
Coax. traverse left..  
steady.. on  
One two hundred  
Men  
Fire"

Orders to the driver indicating the speed, if moving.

Range.  
Type of target.

(ii) Correction.

"Stop

Corrections for elevation at ranges over 1000 yards are usually made by bracketing.

Up two hundred (or  
up four)  
Fire".

(b) SEMI-INDIRECT.

Example 6.

(i) Initial orders.

"Stand by... turret down..  
coax  
Driver right... O.K..  
slow down... halt.  
Traverse right... steady..  
on.  
Level gun

Warning order to the crew, especially to the loader.

Orders to the driver.  
Laying for line.

Up one turn, up eight.

The gun will be levelled by means of the clinometer.  
Elevation is given from gun level in turns and divisions of the elevating wheel.

Fire".



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(ii) Correction

"Left five

Up one turn

Fire".

"Down eight

Fire".

Corrections for line are given in divisions of the traverse indicator, or telescope deflection scale. Corrections for elevation are given in divisions of the elevating wheel.

Further correction for elevation made by halving the bracket.

4. IMMEDIATE FIRE ORDERS.

"17-pr traverse right ... on

Three hundred  
Fire".

For engaging an obvious target the fire order must be kept as short as possible.

5. SUMMARY OF PROCEDURE AND ORDERS FOR TROOP HE SHOOT

Procedure by Troop leader.	Orders by Troop leader.		
	To whom.	Means of communication.	What he says.
1. He warns the troop	Troop	R/T	"Hullo three Troop turret down shoot Eighty-eights in hedgerow Over .
2. He prepares to range	Crew	I.C.	"Stand by turret down shell. Driver right...O.K.... Halt Traverse right...steady... on Four five hundred Check crest clearance" (Loader reports "Crest clear") "Load and fire".
3. He continues to range and when ranging is complete, checks the final reading of the range drum.	-	-	-
4. He passes the final elevation (in yards) to the other crew commanders who proceed to register the target.	Troop	R/T	"Hullo three Four one five zero Register Out".
5. He observes the fire of the tanks while they register and waits for the signal that registration is complete.	-	-	-

He decides to go to fire for effect.  
When the commanders have reported ready by raising one hand, he gives the signal to fire.  
He observes the effect and corrects if necessary.  
He notes the line and range to the target for future engagement.

6. SHOOTING AT MOVING

"Driver halt  
17-pr traverse  
Eight hundred.  
Panther  
Aim right

Fire".



6. He decides to go to fire for effect.	Troop	R/T	"Hullo three Three rounds gunfire. Out".
7. When the commanders have reported ready by raising one hand, he gives the signal to fire.	Troop	Hand	
8. He observes the effect and corrects if necessary.			
9. He notes the line and range to the target for future engagement.			

#### 6. SHOOTING AT MOVING TARGETS.

"Driver halt  
47-pr traverse right...on  
Eight hundred.  
Panther  
Aim right  
  
Fire".

The commander will state the direction of aim-off.  
The gunner will aim-off by the correct amount.

Corrections for line are given in divisions of the traverse indicator, or telescope deflection. Corrections for elevation are given in divisions of the elevating wheel.  
Further correction for elevation made by halving the bracket.

For engaging an obvious target the fire order must be kept as short as possible.

HE SHOOT

Troop leader.  
What he says.

"Hullo three  
Troop turret down shoot  
Eighty-eights in hedgerow  
Over .

Stand by turret down shall  
Driver right...O.K... Halt  
Traverse right...steady... on  
Four five hundred  
Check crest clearance"  
(Loader reports "Crest clear")  
"Load and fire".

"Hullo three  
our one five zero  
gister  
t".



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APPENDIX "A" - ARMAMENT TOOLS AND SPARES.

The following lists are based chiefly on "Provisional Table 154 Challenger I" of the "Tables of Tools and Equipment for "A" vehicles" issued in MAY, 1944 by the War Office (WS 5(a)). Items marked with an asterisk are included in A.F. G1098.

1. 17-pr TOOLS AND SPARES (carried ON the vehicle)

NAME	SCALE PER VEHICLE	PART NUMBER	REMARKS
1.Box, small parts M.G.No.4, Mk.1.	1	BE 6063	
2.Box, spares and tools AFV gun and mounting.	1	CIM(T) 789	
3.Drift, No.18 Mk.1	1	CM 2015	
4.Drift, No.27 Mk.1	1	CM 2017	
5.Gauge, striker protrusion No.38 Mk.1	1	CM 4040	
6.Injector, oil or petrol.	1	13822	
7.Key, removing jammed cartridge, No.10	1	NA 5525	
8.Lanyard, cocking No. 4. Mk. 2.	1	CM 3707	
9.Pliers, flatnose 6"	1	FA 15845	
10.Spanner No.244 for adjusting sight clinometer	1	CM 1891	
11.Spanner, box tubular DE 1/4" x 5/16"	1	FA 17226	
12.Screwdriver, London pattern 5 ins.	1	FA 16786	
+ 13.Spanner BA open-jaw DE 0 - 1.	1	FA 17186	Return spring of firing gear.
+ 14.Spanner BA open-jaw DE 2-3	1	FA 17188	
+ 15.Spanner BA open-jaw DE 4-5	1	FA 17190	
+ 16.Spanner BA open-jaw DE 6-7	1	FA 17192	
17.Spanner BSW box, tubular DE 1/4" x 5/16"	1	FA 17226	
+ 18.Spanner BSW box, tubular DE 1/2" x 9/16" OR	1	FA 17229	For buffer filling plug.
+ 19.Spanner BSW, box tubular DE 9/16" x 9/16"	1	FA 17221	For buffer filling plug

NAME

20. Spanner adjusting  
buffer control

21. Spanner, BSW open-  
valve.  
DE 1/8" x 3/16"

22. Spanner BSW open-  
DE 3/8" x 7/16"

23. Wrench, BSW heavy  
offset 3/4"

24. Spanner, adjust  
11"

25. Tommy No.3

26. Tommy No.5

27. Wrench Set so  
5/32"

28. Pins, keep s  
1/16"

29. Pins, keep s  
1/16"

30. Pins, keep  
3/32" x

31. Pins, keep  
3/32" x

32. Pins, keep  
1/8" x

33. Pins, keep  
1/8" x

34. Pins, kee  
1/8" x

35. Pins, ta  
1/8"

36. Brushes,  
3" No.4  
OR

37. Cleaner  
Mk.1

38. Stave,  
Mk.

39. Stave  
No.2

40. Can,  
patt  
with  
spo



N.M.E.	SCALE PER VEHICLE	PART NUMBER	REMARKS.
20. Spanner adjusting buffer control valve.	1	BC 49704	
21. Spanner, BSW open-jaw, DE 1/8" x 3/16"	1	FA 17233	For MG firing lever adjustment.
22. Spanner BSW open-jaw DE 3/8" x 7/16"	1	FA 17235	For MG mounting adjustment.
23. Wrench, BSW heavy duty offset 3/4"	1	Brit.No.5140	For bolts, securing basket ring to turret base plate.
24. Spanner, adjustable 11"	1	FA 17005	
25. Tommy No.3	1	FA 17598	For item 17 above.
26. Tommy No.5	1	FA 17600	For item 19 above.
27. Wrench Set screw 5/32"	1	FA 19614	For vertical shaft of firing gear.
28. Pins, keep split 1/16" x 1/2"	3	GA 0793	
29. Pins, keep split 1/16" x 1"	3	GA 0801	
30. Pins, keep split 3/32" x 1"	3	GA 0821	
31. Pins, keep split 3/32" x 1 1/2"	3	GA 0822	
32. Pins, keep split 1/8" x 1"	3	GA 0842	
33. Pins, keep split 1/8" x 1/2"	3	GA 0843	
34. Pins, keep split 1/8" x 2"	3	GA 0844	
35. Pins, taper split 1/8" x 1"	3	GA 4168	
36. Brushes, piassaba 3" No.4, Mk.1	1	CM 919A	
OR			
37. Cleaners, Bore No.1 Mk.1	1	CM 930A	
38. Stave, end No.72 Mk.1	1	CM 692A	
39. Stave, intermediate No.2, Mk. 1	4 (or 5 if item 36 is issued)	CM 691A	
40. Can, oil Wesco pattern 1/2-pint with flexible spout.	1	32797.	

AND SPARES.  
 "Provisional Table 154 Challenger"  
 "vehicles" issued in MK, marked with an asterisk are  
 (vehicle)

PART NUMBER	REMARKS
BE 6063	
CIM(T) 789	
CM 2015	
CM 2017	
CM 4040	
13822	
NA 5525	
CM 3707	
15845	
CM 1891	
17226	
16786	Return spring of firing gear.
17186	
17188	
17190	
17192	
17226	
17229	For buffer filling plug.
17221	For buffer filling plug.



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2. .30" BROWNING TOOLS AND SPARES.

NAME	SCALE PER VEHICLE.	Part NUMBER.	REMARKS.
1. Brush, cleaning chamber, M6.	1	M3 -01-01930	
2. Brush, cleaning, M2	3	M3-01-02020	
3. Can, tubular	1	M3-01-02480	
4. Case, cover, group	1	A6-03-00042	
5. Case, rod cleaning, M1.	1	M3-01-03160	
6. Case, spare bolt, M2	1	A10-01-00300	
7. Chest, ammunition, calibre, .30-in	5	G103-15-24428	
8. Extractor, ruptured cartridge	1	A19-01-00820	
9. Envelope, spare parts.	1	M3-01-04590	
10. Mount (tripod, complete with pintle and elevating mechanism)	1	A1-01-00790	
11. Oiler, rectangular 12-oz w/cap and chain	1	M3-01-10050	
12. Rod, cleaning, jointed, M1	1	M3-01-12690	
13. Roll, spare parts, M13 (empty)	1	M8-01-00990	
14. Roll, tools, M12	1	M8-01-01110	
15. Screwdriver, combination M1	1	C.68338	
16. Wrench - Combination M6	1	A6-03-00310	
17. Socket, front barrel bearing plug.	1	A6-03-00320	
18. Bands, lock, front, barrel bearing	1	A6-01-00020	
19. Bands, lock, front barrel bearing plug	1	A6-01-00030	
20. Barrel	1	A6-01-00050	
21. Bolt group Comprising:-	1		
a. Bolt assembly (1)		A5-01-00180	
b. Extractor assembly (1)		A5-01-00541	
c. Levers, cocking (1)		A5-01-00800	
d. Pin, firing, assembly (1)		A5-01-01090	
e. Pins, cocking lever (1)		A5-01-01010	
f. Rod, driving spring assembly (1)		A5-01-01780	
g. Sears (1)		A5-01-01950	
h. Spring sear, assembly (1)		A5-01-02300	
i. Spring, driving (1)		A5-01-02191	

21. Cover group  
Comprising:-  
a. Cover assembly (1)  
b. Levers, feed bolt  
c. Pawls, feed bolt  
d. Pin, belt feed pawl assembly (1)  
e. Pivot, bolt feed group assembly  
f. Slide feed bolt assembly  
g. Springs, cover extractor (1)  
h. Springs, feed pawl (1)  
22. Extension, barrel group -  
Comprising:-  
a. Extension barrel assembly (1)  
b. Locks, breech  
c. Pin, breech assembly (1)  
d. Springs, lock barrel (1)  
23. Frame, lock, Comprising:-  
a. Accelerator  
b. Frame lock  
c. Pin accelerator assembly  
d. Pins, trigger  
e. Trigger barrel assembly  
f. Springs, plunger  
g. Springs pin (1)  
h. Trigger  
24. Levers,  
25. Levers,  
26. Levers,  
27. Nuts, be pivot  
28. Pawls,  
29. Pawls  
30. Pin a  
31. Pin  
32. Pin  
33. Pin  
34. Pin  
35. Pin



NAME	SCALE PER VEHICLE	PART NUMBER	REMARKS.
22. Cover group Comprising:- a. Cover assembly (1) b. Levers, feed belt (1) c. Pawls, feed belt (1) d. Pin, belt feed pawl, assembly (1) e. Pivot, belt feed lever group assembly (1) f. Slide feed belt assembly (1) g. Springs, cover extractor (1) h. Springs, feed belt pawl (1)	1	A6-01-00340 A5-01-00820 A5-01-00900  A5-01-00960 A5-01-01205 A5-01-02040 A5-01-02160 A5-01-02100	
23. Extension, barrel group - Comprising:- a. Extension barrel assembly (1) b. Locks, breech (1) c. Pin, breech lock assembly (1) d. Springs, locking, barrel (1)	1	A5-01-00490 A5-01-00830 A5-01-00930 A5-01-02240	
24. Frame, lock, group Comprising:- a. Accelerators (1) b. Frame lock assembly (1) c. Pin accelerator assembly (1) d. Pins, trigger (1) e. Hunger barrel assembly (1) f. Springs, barrel plunger (1) g. Springs, trigger pin (1) h. Triggers (1)	1	A5-01-00010 A5-01-00570  A5-01-00230 A5-01-01170 A5-01-01520 A6-01-1240 A5-01-02320 A5-01-02470 A5-01-00800	
25. Levers, cocking	1	A5-01-00820	
26. Levers, feed belt	1		
27. Nuts, belt feed lever pivot bushing	1	A5-01-00841 A5-01-00900	
28. Pawls, feed belt	1	A5-01-00910	
29. Pawls, holding belt	1		
30. Pin accelerator assembly	1	A5-01-00930 A5-01-01090	
31. Pin firing assembly	1	A5-01-01010	
32. Pins, cocking lever	1		
33. Pins, belt holding pawl split	1	A5-01-00970 A5-01-01170	
34. Pins, trigger	1		
35. Pivots, belt feed lever	1	A5-01-01190	



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Name.	SCALE PER VEHICLE.	PART NUMBER.	REMARKS.
36.Plugs, front barrel bearing.	1	A6-01-00890 A5-01-01805	
37.Screws, lever pivot	1		
38.Spring sear assembly	1	A5-01-02300	
39.Springs, barrel plunger	1	A6-01-01240	
40.Springs, belt feed pawl	1	A5-01-02100	
41.Springs, belt holding pawl	1	A5-01-01240	
42.Springs, cover extractor	1	A5-01-(2160)	
43.Springs, locking barrel	1	A5-01-02240	
44.Springs, trigger pin	1	A5-01-02320 A5-01-02470	
45.Triggers	1		
46.Washers, lock	1	H1-15-19004.	

STATEMENT OF 17-PR AMMUNITION				PROPELLANT	
PROJECTILE	Filling	Tracer	FUZE	Type	Weight
Weight			Mark		8 lbs 2 ozs.
Length				NH 055	
Mark.		Yes		NH 033	6 lbs 10 ozs 12 oz.
COMPLETE ROUND					
Weight.					



APPENDIX "B" STATEMENT OF 17-PR AMMUNITION

131.

NAME OF CARTRIDGE	COMPLETE ROUND		Mark.	PROJECTILE				FUZE Mark	Action	PROPELLANT	
	Length	Weight.		Length	Weight	Filling	Tracer			Type	Weight
1. Cartridge QF 17pr, Shot APCBC/T Mk.1	34.5 ins	35.5 lbs	Mk. 8	-	17 lbs	-	Yes	-	-	NH 055	8 lbs 2 ozs.
2. Cartridge QF 17pr, Shot APDS/T Mk.1B	30 ins (approx)	24.7 lbs (approx)	Mk.1B		7 lbs 10 ozs 14 dr.	-	No.22	-	-	NH 033	6 lbs 10 ozs 12 dr.
3. Cartridge, QF 17pr, Shot APC/T Mk.1	31.7 ins	35.5 lbs	Mks.1-4	9.1 ins (Mks 1&4)	17 lbs	-	Yes	-	-	NH 055	8 lbs 2 ozs.
				10.1 ins (Mks 2&3)							
4. Cartridge, QF 17pr, Shot AP/T Mk.1	32.14 ins	35.5 lbs	Mks. 2, 3 & 6.		17 lbs	-	Yes	-	-	NH 055	8 lbs 2 ozs.
5. Cartridge, QF 17pr, Shell HE/T Mk.1	32.28 ins	30.4 lbs (full ch.)	Mk.2T		13 lbs 6 ozs.	TNT	No.13	No.244 Mks. 3 & 4.	Direct action with slight delay.	NH 055(full)	6 lbs 11 ozs.
		25.1 lbs (red.ch.)								Cordite VM 017 (reduced)	1 lb 10 ozs.
6. Cartridge QF 17pr, Shell HE/T Mk.2.	32.28 ins	30.4 lbs (full ch.)	Mk.2T		13 lbs 6 ozs	TNT	No.13	No.257 Mk.1.	Direct and super-quick.	NH 050(full)	6 lbs 11 ozs
		25.1 lbs (red.ch.)								Cordite VM 017(reduced)	1 lb 10 ozs.
7. Cartridge, QF 17pr, shell HE/T, Super hc					14 lbs 2 ozs 8 dr.			No.257 Mk.1.	Direct and super-quick.		
8. Cartridge, QF 17pr, Practice Shot, Mk.1T	32.09 ins		Mks.1-6, 8 & 9.		16 lbs 15 ozs (Mks.1, 3, 8 & 9) 15 lbs 11 ozs. (others)	-	Yes	-	-	NCT 065	7 lbs. 14 ozs.



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APPENDIX 'C' - PARTICULARS OF THE 17-PR GUN  
(for reference).

AMMUNITION (service types).

Cartridge 17 pr. shot APCBC/T Mk. 1.  
Cartridge 17 pr. shot APDS/T Mk. 1B.  
Cartridge 17 pr. shell HE/T Mk. 1 or 2 (full or reduced charge).  
Cartridge 17 pr. shell HE/T super high capacity.

BREECH BLOCK.

Vertical sliding type.  
Semi-automatic action.

CONDEMNING LIMITS.

For mean wear at 1 inch from commencement of rifling - 0.25 inches.  
For scoring plus half wear - 0.670 inches.

DIAMETER

Bore - 3 inches  
Gauge, plug bore - 2.990 inches.

EFC VALUES.

1 full charge NH - 0.25 EFC  
1 full practice charge NCT - 0.50 EFC.  
32 reduced charges NH - 1 EFC.  
(Auth. EMER Armament A 520 dated 22 Dec. 1944).  
32 reduced charges Cordite WM 017 - 1 EFC.

GAUGES USED.

Clearance firing-hole bush to cartridge - No. 49.  
Striker protrusion - No. 38.

LENGTH.

Bore - 165.45 inches.  
Gun complete with breech mechanism and muzzle brake - 173.55 inches.  
Complete round  
APCBC - 34.5 inches.  
APDS - 30.0 inches (approx).  
HE/T Mk. 1 or 2 - 32.28 inches.  
HE/T super HC: - - -

LIFE OF GUN (probable).

350 EFC (Auth. EMER Armament A 520 dated 22 Dec. 1944).

MUZZLE VELOCITIES

APCBC - 2900 ft/sec.  
APDS - 3950 ft/sec.  
HE/T (full charge) - 2950 ft/sec.  
HE/T (reduced charge) - 1800 ft/sec.

PROTRUSION OF STRIKER  
TRAVEL OF PROJECTILE  
HEIGHT.

Gun complete.

Projectile

APCBC

APDS

HE/T

HE/T Super H

Charge.

Full (APCBC)  
Full (APDS)  
Full (AP P)  
Full (HE)  
Reduced (H)

Complete r

APCBC

APDS

HE/T (f

HE/T (r

HE/T su



PARTICULARS OF THE 17-PR GUN  
(For reference).

or reduced charge).

rifling - 0.25 inches.  
- 0.670 inches.

- 3 inches  
- 2.990 inches.

- 0.25 EFC  
- 0.50 EFC.  
- 1 EFC.  
1944).  
- 1 EFC.

- No. 49.  
- No. 38.

- 165.45 inches.  
- 173.55 inches.

- 34.5 inches.  
- 30.0 inches (approx).  
- 32.28 inches.  
- - -

4).

133.

PROTRUSION OF STRIKER

- 0.09 - 0.11 inches.

TRAVEL OF PROJECTILE

- 144.03 inches.

WEIGHT.

Gun complete.

- 17 cwt. 1 qr. 7 lbs.

Projectile

APCBC

- 17 lbs.

APDS

- 7 lbs. 11 ozs.

HE/T

- 13 lbs. 6 ozs.

HE/T Super HC

- 14 lbs. 3 ozs.

Charge.

Full (APCBC)

- 8 lbs. 2 ozs. NH 055.

Full (APDS)

- 6 lbs. 11 ozs. NH 033.

Full (AP Prac)

- 7 lbs. 14 ozs. NCT 065.

Full (HE)

- 6 lbs. 11 ozs. NH 050

Reduced (HE)

- 1 lb. 10 ozs.

Cordite WM 017.

Complete round.

APCBC

- 35.5 lbs.

APDS

- 24.7 lbs. (approx).

HE/T (full charge).

- 30.4 lbs. (approx).

HE/T (reduced charge)

- 25.1 lbs. (approx).

HE/T super HC

- - -





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APPENDIX 'D' - GLOSSARY OF TERMS.

AIM-OFF	The amount by which the sight is laid off laterally from the centre of the target usually to allow for the movement of the target or for the movement of the vehicle from which the gun is fired.
ANGLE OF PROJECTION	The <b>vertical</b> angle which the line of departure makes with the line of sight.
ANGLE OF SIGHT	The angle which the line of sight makes with the horizontal plane. It is <u>positive</u> when the line of sight is above the horizontal plane and <u>negative</u> when the line of sight is below the horizontal plane.
AXIS OF THE BORE	The line passing through the centre of the bore.
BEATEN ZONE	The area on the ground covered by a number of rounds fired in the same conditions.
BRACKET FOR ELEVATION	A pair of elevations, of which one has given a plus round and the other a minus.
CALIBRATION	The process of determining the accuracy of a gun as compared either with that of a gun of range table performance (absolute calibration) or with that of another gun taken as standard (comparative calibration).
C.E.	Composition exploding (or tetryl).
DRIFT	The lateral deviation of a projectile from the <b>line</b> of departure owing to its rotation.
DROOP	The vertical angle between the axis of the bore at the breech and the axis of the bore at the muzzle.
E.F.C.	Equivalent full charges. The basis of computing the value of propellant charges. Full charge cordite MD, SC, W or WM or nitrocellulose double-base (FNH/DB) = 1 EFC.
ENFILADE FIRE	Fire laid down the length of a target.
FIRING INTERVAL	The interval measured from the time the gunner aligns his sights on the target to the moment the projectile leaves the bore.
FOULING, INTERNAL	Caused by the products of combustion being forced into the pores of the metal in the bore.
FOULING, METALLIC	Caused by part of the envelope or driving band of the projectile being left on the surface of the bore.

SUPERFICIAL  
OF DEPARTURE  
OF SIGHT  
BRACKET  
POINT OF IMPACT (m)  
Muzzle Velocity  
OGIVE  
QUADRANT ELEVATION  
REMAINING VELOCITY  
SHORT BRACKET  
SIGHTS  
STRIKING VELOCITY  
TANGENT ELEVATION  
TIME OF FLIGHT  
TRAJECTORY  
W.P.  
ZEROING



Caused by the waste products of combustion or by dirt, dust and moisture remaining on the surface of the bore.

Hexachlorethane - a smoke producing composition.

The vertical angle between the direction of the axis of the bore immediately before firing and the line of departure. When the line of departure is above this direction, the jump is said to be positive, when below, negative.

To point the axis of the gun in the direction estimated for the projectile to hit the target.

The direction of the projectile as it leaves the bore.

The straight line passing through the sights and the target.

A multiple of the short bracket, varying usually from one-eighth to one quarter of the range.

A point which represents the mean position of the points of impact of a number of rounds fired in the same conditions.

The velocity of the projectile at the muzzle of the gun.

The curved portion of the nose of the projectile.

The angle which the axis of the bore when the gun is laid, makes with the horizontal plane.

The velocity of the projectile at any point of the trajectory.

A pair of elevations which bracket the target and which differ approximately by twice the 50% zone of the gun at the range concerned.

The means of giving the correct alignment to the axis of the bore.

The velocity of the projectile at the point of impact.

The vertical angle which the axis of the bore when the gun is laid, makes with the line of sight. It differs from the angle of projection by jump and droop.

The time taken by the projectile to reach the point of arrival reckoned from the moment it leaves the muzzle.

The curve described by the projectile in flight.

White phosphorus - a smoke producing composition.

The process of adjusting the sights so that the line of sight and point of impact coincide at a given range and of recording the adjustment.

POULING, SUPERFICIAL

H.C.E.

JUMP

LAYING

LINE OF DEPARTURE

LINE OF SIGHT

LONG BRACKET

MEAN POINT OF IMPACT (m.p.i.).

MUZZLE VELOCITY

OGIVE

QUADRANT ELEVATION

REMAINING VELOCITY

SHORT BRACKET

SIGHTS

STRIKING VELOCITY

TANGENT ELEVATION

TIME OF FLIGHT

TRAJECTORY

W.P.

ZEROING